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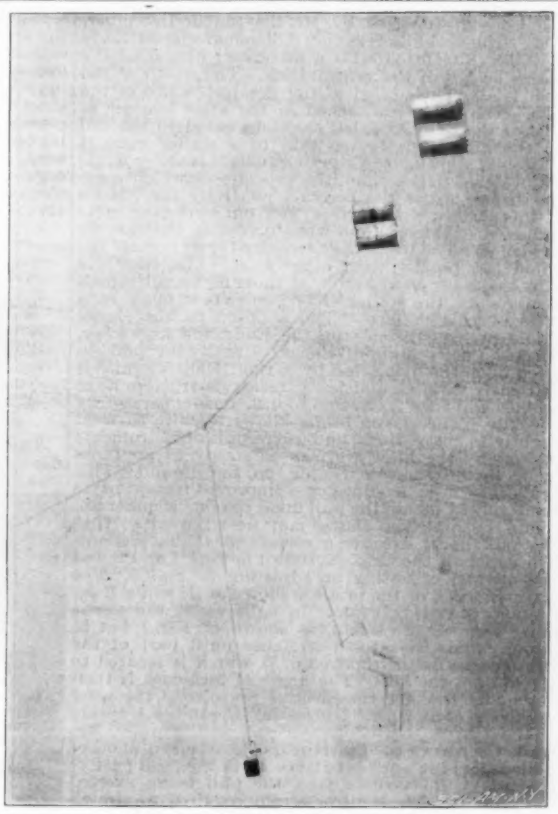
BEGINNING OF AN ASCENT.



KITES CARRYING METEOROGRAPH.

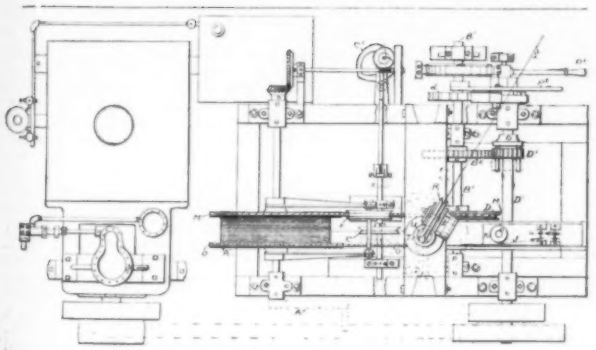


Fig. 8.

Fig. 3

Fig. 4.

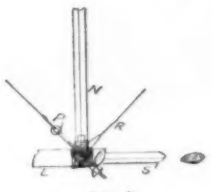


Fig. 5.

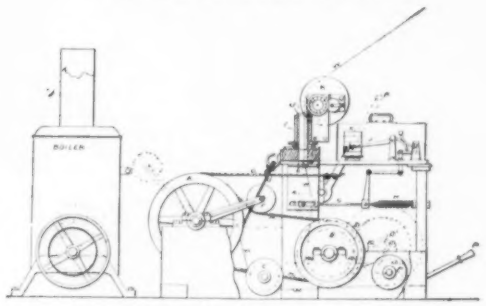


Fig. 9.

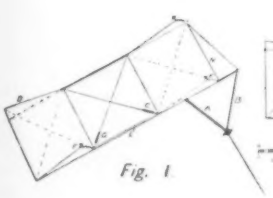


Fig. 1

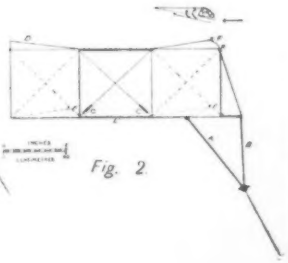


Fig. 2

Fig. 6

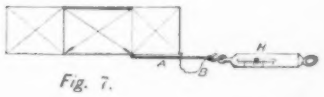


Fig. 7.

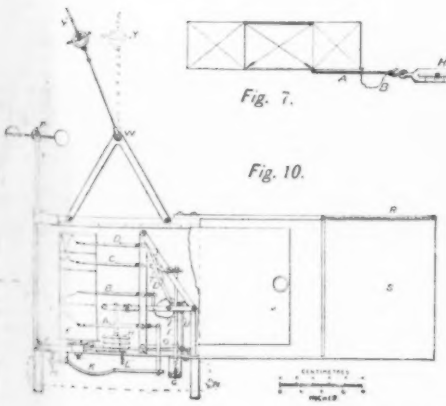
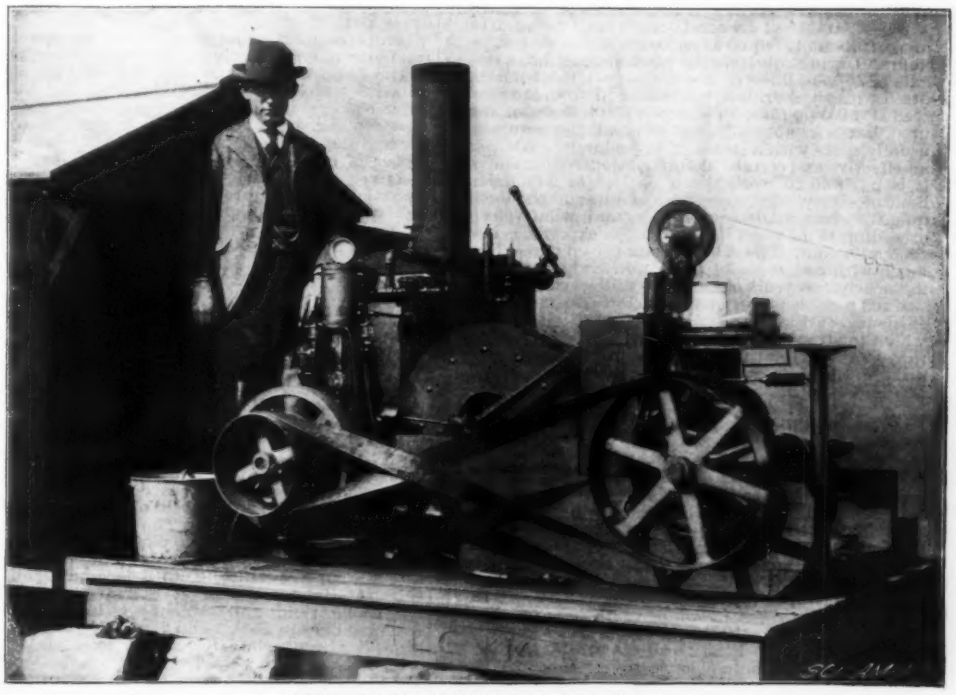


Fig. 10.



STEAM POWER WINDLASS FOR KITES.

METEOROLOGICAL EXPERIMENTS WITH KITES AT BLUE HILL OBSERVATORY.

PROGRESS OF EXPERIMENTS WITH KITES IN 1897-98 AT BLUE HILL OBSERVATORY.

By S. P. FERGUSSON.

THE results of the kite experiments at Blue Hill from 1894 to 1897 were published in the Annals of Harvard College Observatory, Vol. XLII. For the purpose of extending the exploration of the air to heights exceeding 10,000 feet, Mr. Rotch, the director of Blue Hill Observatory, obtained in February, 1897, a grant from the Hodgkins fund held by the Smithsonian Institution. In this paper will be given a brief account of the progress of the work during 1897 and 1898.

IMPROVEMENTS IN KITES.—One of the most serious problems was that of rendering the kites adjustable to great extremes of wind velocity so that the strain upon the frames of the kites and upon the line during gales would not become excessive. The work of improving the kites in this particular has been in the hands of Mr. Clayton. The first successful adjustable kite was the keel kite devised by Mr. Clayton in December, 1896. The keel kite is simply a diamond-shaped Eddy or Malay kite fitted with a fin or keel extending the entire length of the central stick. The width of the keel is about one-third of the greatest width of the kite. The bridle is attached in the same manner as that of the Eddy kite, but the end secured to the tail of the kite is elastic, so that in a strong wind it stretches, allowing the kite to assume a smaller angle of incidence to the wind, the pressure of which upon the surface of the kite becomes relatively less. Kites of this pattern usually flew well but were very liable to become distorted; and when driven to one side by sudden shifts of wind, they recovered their normal position less rapidly than other kites. The Hargrave kite being the most stable of those in use, all experiments since the spring of 1897 have been made with kites of this pattern. The addition of the elastic bridle, previously tried on the Eddy and keel kites, effected a marked improvement. Usually the pull exerted upon the flying line by a rigid Hargrave kite is extremely variable and jerky, hence destructive alike to line and kite frame and to instruments carried by the kite. The elastic bridle allows the kite to yield slightly to gusty winds, and the records of instruments carried by the kites are now as steady as are those made by instruments resting on the ground. This bridle has been modified and improved from time to time, and by its use the pull upon the line is under absolute control. The elastic may be adjusted so that the pull never exceeds a certain maximum amount. The action of the bridle is shown in Figs. 1 and 2 and the method of testing or adjusting in Fig. 3. The elastic portion of the bridle is shown at *A*, while *B* represents the rigid portion. In light winds the elastic alone receives the strain, as shown in Fig. 1, but in strong winds the elastic stretches until part of the strain comes on the rigid cord, *B*, which is secured to the front of the kite. The angle of incidence is then very much less, and the effective pressure of the wind relatively diminished. In testing the bridle, a spring balance, *H*, is secured to the ring in the bridle, and while the rear of the kite is held by one person, another pulls upon the spring balance until the rigid part of the bridle, *B*, becomes taut, the pull being exerted horizontally. The pull or strain required to stretch the elastic, until the slack in the rigid part, *B*, is taken up, is the maximum amount of pull that the kite will exert when in the air. On account of the inertia of the kite, in high, gusty winds the extremes of pull sometimes exceed the rating slightly; but in such cases the kites were always near the ground, where the wind is more unsteady than it is at great heights. The elastic portion of the bridle is usually made strong enough to allow the kite to exert a pull of one pound per square foot of lifting surface. As an instance of the efficiency of this bridle, one of the tests of kites for "range of velocity" may be mentioned. Two kites, one with adjustable and the other with rigid bridle, were sent up in a gale of 50 miles an hour. The self-adjusting kite was arranged to pull a maximum of about 30 pounds, or 1 pound per square foot, and during the entire test the pull never exceeded this quantity. The rigid kite was a smaller one, and pulled between 60 and 108 pounds and averaged 8 pounds per square foot. On another occasion the main line broke at a defective splice when five kites were in the air. The lowest kite caught in a tree several miles from the windlass, and the four remaining kites, having a total area of about 130 square feet, were in the air nearly 24 hours. During this time the wind increased to a strong gale of 40 to 65 miles an hour, and had the kites been fitted with rigid bridles, the total pull would have exceeded 1,000 pounds. The actual pull was not measured, but was not sufficient to break the wire, which usually parts with a strain of 300 pounds. With such an effective and certain method of controlling the pull, it is possible to work the main line to its maximum limit of safety. The total area of kites on the line frequently exceeds 200 square feet, and wind velocities exceeding 40 miles an hour are often experienced with such a line out. The elastics do not seem to deteriorate much with use, some of those on hand at present being nearly two years old and are still serviceable

Much time has been spent in efforts to improve the efficiency of the kites. All the sticks, wires, etc., of which the frames are constructed are so shaped or arranged as to offer the least possible resistance to the air, and the cloth covers are thinly coated with paraffine and ironed, so that a comparatively smooth and impervious surface is obtained. It was found that increasing the width of the rear cell of the kite caused it to fly at a higher angle, but since the pressure of the wind is much less on the rear than on the front cell, the increased weight rendered the kite less effective in light winds. When the incidence of plane-surfaced kites is small, as it is when the elastic bridle is employed and the kite flown in high winds, the wind pressure upon the edges of the kite drive it backward and downward; and while such kites fly safely in and are not injured by higher velocities, the angular altitude reached is so low that very little is gained in attempts to fly them in wind velocities exceeding 40 miles an hour. In the summer of 1898 some experiments were made with the object of eliminating the edge pressures as much as possible. In some recent papers published in the Proceedings of the Royal Society of New South Wales, Mr. Hargrave shows that by making the supporting surfaces curved, with the deepest part of the curve near the front edge, there is a very great gain in efficiency. The air passing under the concave surface, as shown in Fig. 2, forms a vortex, which, reacting on the front of the surface, tends to move it forward against the wind. According to Mr. Hargrave, the surface must be rigid, since a vortex does not form when the curve is not rigid; and the vortex is most effective at very small angles of incidence. Mr. Hargrave has built two small kites on this principle, both of which soar in or beyond the zenith. Soaring kites are usually not very stable, and with the object of retaining the stability of the older patterns of kites, two kites with the new curved surfaces were built at Blue Hill in 1898. In the first of these, built in June, 1898, the depth of the curves was about one-twelfth of their width. The best cellular kite tried previously was Lamson's "areocurve," which, flown by a short line, reached an angle of 58°, this being the average of ten observations with a transit at intervals of 30 seconds. The new kite averaged 62°. In the second of the improved kites the depth of the curve in the lifting surfaces was one-eighth the width of the surface. The shape of the surface is shown approximately in Figs. 1 and 2. The front part of the curve between the two cross marks is stiffened with a thin sheet of wood veneer, so that its shape is not altered by pressure on the outside. This kite has reached the highest angular altitude of any that has been measured. The average of ten consecutive observations at regular intervals was 66°, while the average of forty observations was 62°. The dimensions of the two kites are given in the following table:

	Serial No. 16. First Kite.	Serial No. 17. Second Kite.
Length of kite	108 inches.	40 inches.
Width of kite	96 "	60 "
Width of each cell	34 "	13 "
Height of each cell	36 "	13 "
Width of space between cells	40 "	14 "
Depth of curve in surface	3 "	1·5 "
Distance of greatest depth of curve from front edge	9 "	2·0 "
Area of lifting surfaces	91 sq. ft.	22 sq. ft.
Total area of kite	125 "	31 "
Total weight of kite	11 lb. 4 oz.	2 lb. 10 oz.
Weight per square foot of lifting surface	2·0 oz.	2·0 oz.

The effect of the edge pressures on these kites is not nearly so great as it is on kites with flat surfaces, and there is very little loss of angular altitude in very strong winds. The second kite was not so stable as the others, and a short rudder was attached to the back of the rear cell to improve it in this respect. The upper part of the rear cell (as shown in Figs. 1 and 2) is bent upward at an angle of 10°, to prevent the kite from assuming a negative angle under strong pressure. In the first kite adjustment of the wire guys was obtained by means of turnbuckles, *C C*, Fig. 1. At the outer corners of the cells the guys were adjusted as shown in Fig. 5. *R* is the wire guy which is secured to the screw eye, *P*, which passes diagonally through the corner of the kite frame, of which *N*, *L*, and *S* are, respectively, the vertical, longitudinal, and lateral sticks. The sticks are joined together by first fitting them to each other as shown in Fig. 4, then, after coating them with glue, they are lashed securely with linen thread, as shown in Fig. 5. Sometimes a strip of cloth, *O*, is used to hold the sticks in place during the process of lashing, but this is not necessary to the strength of the joint. This joint was devised by Mr. George A. Young, of Roslindale, Mass., and is the best we have found so far. Aluminum strips were used at first, and these were bolted to the sticks, but such joints were heavy, insecure, and large. The new joint is not appreciably larger than the sticks, and the weight of the wrapping is less than that in any form of joint we have tried. The sticks now employed are nearly pear shaped in cross section, the greatest thickness being one-third of the greatest width of the stick from its front edge. This shape has been adopted on the recommendation of Mr. Octave Chanute, who determined by experiment that it offers less resistance to the wind than any other. The best spruce wood is used for sticks. Nainsook cloth has been used as a covering for kites from the beginning, but the last kite was covered with silk, to determine the fitness of this material for covers. The wire guys, which hold the frame rigid and which are indicated by the diagonal lines in Figs. 1 and 2, were formerly made of phosphor bronze, but since the summer of 1897 music wire has been employed with much better results. Music wire is attacked more or less by rust, but guys made of it last as long as the other parts of the kite, besides are much stronger, lighter, and more pliable. In guying a kite it is best to true up the frame as a whole, first, by running one set of wires diagonally across the entire length of the kite and another set across laterally, care being taken to keep all sticks and edges straight and all corners true rectangles. Frequent measurements with try-square and straight edge will show any irregularity. It will then be easier to put in the shorter guys.

BIRD'S EYE VIEW OF BLUE HILL OBSERVATORY TAKEN FROM A KITE BY W. A. EDDY.

LINE.—The main line for flying kites is made of steel music wire, No. 14 gage, which is 0·0325 inch in diameter, weighs 15 pounds for each mile of length and breaks at 300 pounds strain. It is usually worked at less than half its breaking strain, but occasionally strains of 175 pounds have been registered. Continuous uniform lengths of 8,000 feet without splice, on spools, can be obtained from the manufacturers by special arrangement, and the making up of a long line is an easy matter. When a strain pulley is employed to relieve the storage drum of the windlass from excessive pressure it is important to have as few splices as possible, and these should be made with the utmost care. The method of splicing followed at Blue Hill is that recommended by Capt. C. D. Sigsbee, U. S. N. The ends of the two wires to be united are cleaned thoroughly and filed to a long tapering point; then they are wound or laid together (not twisted) in the form of a cable-laid twine for not less than eight inches, the tapering ends being closely coiled around the standing parts so as to form a slender taper at each end of the splice. A seizing of very small annealed wire is put on near each end to prevent the ends from loosening, and the whole splice is covered with solder, care being taken not to overheat the wire. A soldering iron just hot enough to melt the solder should be used, and it should not be allowed to rest against the wire longer than necessary to melt the solder. After the soldering, the splice should be cleaned of any acid remaining and oiled to prevent rust. A completed splice is shown in Fig. 6. For convenience in attaching kites to the end of the wire a toggle or ring is secured to the wire, the end being passed several times around the ring or toggle, then laid around the standing part of the wire, and soldered in the same manner as the splice. For attaching tandem kites at any point along the main line the clamp shown in Fig. 7 is recommended. It consists of an aluminum casting provided with two slotted arms to receive the wire, which is clamped firmly by screws. The slot is made by means of a circular saw (a hack saw should not be used) slightly thinner than the wire, and is pried open sufficiently to allow the wire to pass just behind the clamp screws. These clamps are very durable, some of those at Blue Hill having been in use more than two years, and do not injure the wire in the least. The short arm of the clamp is always placed on the outer side, in order that the pull of the kite may come equally upon the two arms.

WINDLASS.—The windlass employed since February, 1897, is a modification of Sir William Thomson's apparatus for deep sea sounding, and is shown in Figs. 8 and 9. The wire is stored upon the drum, *A*, which is an ordinary iron flanged pulley 20 inches in diameter and 4 inches wide. The flanges are grooved for the reception of the driving belt, *M*, and the brake rope, *O*. The drum will hold about 40,000 feet of wire, but the greatest amount used so far is 32,000 feet (10,000 meters). The wire passes from the drum under a pulley, *C*, which, driven slowly backward and forward by means of a cam, C^1, geared to the axis of the drum, distributes the wire uniformly over the face of the drum. A second pulley, *E*, delivers the wire to the strain pulley, *B*, at a slight angle, so that successive turns of wire will not recoil on one another. The wire passes four times around the strain pulley, then over the small pulleys, *a* and *b* (shown by the dotted lines), which form a part of the dynamograph. The pulley, *a*, is carried at the end of the rod, *G*, and with it moves freely in a horizontal guide. The other end of the rod is held by the heavy spring, *H*. When there is no strain on the wire, the spring draws it slightly from a straight line between the strain pulley and the pulley, *b*. Any strain on the wire tends to straighten it and stretch the spring, the motion being transmitted through suitable levers and cams to the pen lever, *J*, which marks the variations in intensity of the strain on the chronograph drum, *k*, which is covered with suitably ruled paper. The course taken by the wire is shown by the line, *W*. By this means a continuous record of the pull is obtained at all times, whether the wire is stationary or moving, and which is very valuable in indicating safe speeds at which to reel in or let out the line. A specimen record is shown in Fig. 12. After leaving the dynamograph the wire passes over the swiveling pulley, *R*, which, supported on the ball-bearing sleeve, *T*, rotates about the hollow spindle, *U*, and takes any horizontal direction assumed by the wire. This pulley is exactly half a meter in circumference and registers upon a dial, *S*, the length of the wire passing over it. The error of the measurement is extremely small, since, after reeling out 8,000 meters or more and winding it in, the dials usually come back to within 10 meters (33 feet) of the zero. The strain pulley is driven by spur gearing, B^2 and D^2, from a countershaft, D^1, on which are mounted two pulleys driven by a belt from the engine. With these pulleys, which are of different diameters and are indicated by dotted lines in Fig 9, the speed of winding can be varied from seven miles an hour to three miles an hour; and by regulating the throttle valve of the engine the speed may be further reduced to a rate of less than one mile an hour. The belt, *M*, driving the storage drum is always kept on the drum and the driving pulley, D^1, and is made ready for use by allowing the tightener, *F*, to rest upon it and removing the brake rope, *O*. In letting out wire the gear, D^2, on the countershaft is removed from its clutch, as shown by the dotted lines, and the brake rope, *O*, placed on the storage drum, *A*. This brake is operated by means of a lever, *P*. When the strain is excessive a second strap brake on the axis of the strain pulley is also employed, the operating lever of which is shown at P^2. A ratchet, *d*, provided with a releasing lever, P^3, serves as a safety check when the strain is variable.

Power for winding is obtained from a two horse power Shipman automatic steam engine, which consumes about one-half gallon of kerosene oil per hour, making 400 revolutions per minute. It will run smoothly at speeds as low as 100 revolutions per minute,

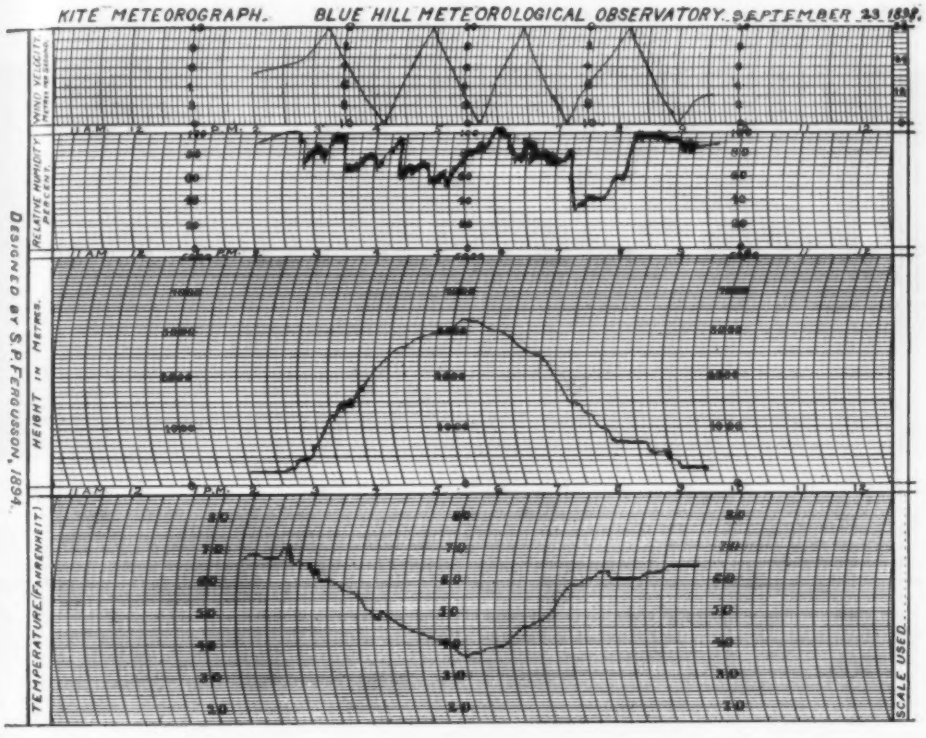
which is a great advantage at times when the strain on the line is variable, since the speed of winding can be adapted to any strain likely to occur.

At first the wire was wound directly upon a strong drum made of hard wood, but this drum was soon crushed by the accumulated pressure of the wire, and the windlass was rebuilt with a strain pulley which receives the full strain of the line, which is then wound on the storage drum at a very light strain. By means of the distributing and regulating devices described the windlass is practically automatic in action, and when it is set in motion for winding it requires no attention except at times when tandem kites are to be removed from the line. A reservoir of oil is arranged to allow about two drops to fall upon the strain pulley during each of its rotations, both for lubrication and to prevent rust. In cold weather and when flights are made in rainy weather the storage drum is covered with heavy paraffine oil as an additional safeguard against rust.

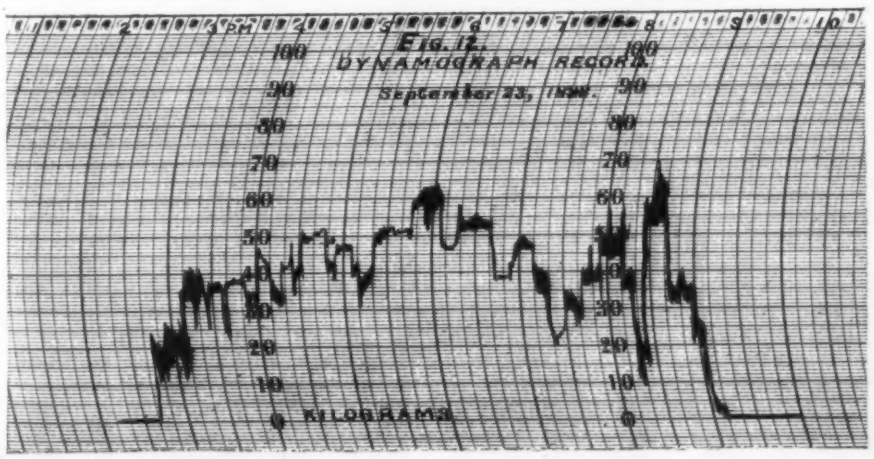
When the strain is very light, a crank may be attached to the axis of the storage drum as shown at A^1, Fig. 9, and the line may be wound in by hand if desired. A photograph showing the external appearance of the windlass accompanies this paper. The small house appearing just behind the engine is arranged to move forward on rollers and cover the entire apparatus when it is not in use.

METEOROGRAPHS.—The meteorograph or recording apparatus carried by the kites is shown in Fig. 10. The height attained in meters, the temperature, humidity, and velocity of the wind are all recorded upon the same chronograph drum by mechanisms of the well known Richard pattern. The aneroid barometer, *H*, records by means of the pen, *B*, the height reached. *K* is the thermometer tube connected with the pen, *A*. The hair of the hygrometer is secured to the bracket, *G*, and through the link, *F*, and cams, *T*, operates the pen, *C*. The anemometer cups, *P*, are connected with the cam, *I*, by means of the spindles, *J* and *U*, and cause the pen, *D*, to move across 10 divisions of its scale during the passage of 36 kilometers of wind (22·4 miles), making a slanting line from which the velocity in meters per second is read. At the back of the instrument is secured a double rudder, *S*, which keeps the end carrying the anemometer always facing the wind and in a horizontal position, so that the anemometer spindle is always vertical, irrespective of the blowing backward of the instrument by the wind. While this method of suspending the instrument is probably the best available at present, the swinging motion about the pivot, *W*, causes unsteadiness of the recording pens in strong winds. Experiments are now in progress which will no doubt result in the elimination of this defect. The tube of the thermometer is screened from direct sunlight by thin strips of wood shown by the dotted figure, *N*. The bulb is also insulated from the metal base plate by strips of hard rubber, and is sheltered entirely from direct radiation from the base plate by a sheet of wood veneering which covers the entire lower surface of the plate. The complete instrument, including the rudder, weighs a little less than three pounds. It is suspended from the kite by means of a ring and toggle at the end of a long cord. These are shown at *Y*, in Fig. 10. Fig. 11 is a facsimile of a record made by this meteorograph on September 23, 1898. Fig. 12 is a fac-simile of a record by the dynamograph on the same date. Another meteorograph recording temperature, humidity and heights and conducted by Richard Frères, of Paris, is also used at times.

FIG. 11.


KITE METEOROGRAPH. BLUE HILL METEOROLOGICAL OBSERVATORY. SEPTEMBER 23 1898.
WIND VELOCITY WITHIN 100 METERS
RELATIVE HUMIDITY PER CENT.
HEIGHT IN METRS.
TEMPERATURE (FAHRENHEIT)
SCALE USED.
DESIGNED BY S.P. FERGUSON, 1894.

Before the meteorograph is attached to the kites it is suspended freely about 5 meters (15 feet) above the ground, in order that its recording mechanisms may adapt themselves to the conditions prevailing at the surface of the earth, and for comparison with the standard instruments. The length of exposure is usually from ten minutes to half an hour, and during that time the kites and windlass are made ready. After sufficient exposure the meteorograph is attached to the end of a cord 15 to 20 meters long which depends from the rear edge of the front cell of the kite. The kite is allowed to rise slowly at first, to prevent jerking of the instrument. On account of the irregular and rough surface of the hill, the first kite is not always flown directly from the windlass, the wire being sometimes passed over a pulley secured at any suitable distance from the windlass. Usually, after about 300 meters of wire are out, the wire is allowed to run directly from the windlass and the pulley is removed. This first kite is a large one, having at least 70 and sometimes 90 square feet of lifting surface, and when this has taken out 300 meters (984 feet) of wire another of the same size is attached by means of the clamp already described. The bridles of these kites are adjusted so that the pull just below the second kite will not exceed 160 pounds. Stops of three to ten minutes are then made when 300, 600, 1,000, 1,500, and 2,000 meters of line are out, another smaller kite being attached at the last point. After this, stops are made after each additional 2,000 meters of wire are out. The same stops are made when the kites are being reeled in, in order to obtain a second set of records at each point, the interval between the ascent and descent serving to show any change in the meteorological phenomena. After it is brought back to the ground the meteorograph is again compared for at least ten minutes with the observatory instruments before the records are removed.



The vertical height of the instrument above the hill is computed by means of the formula

$$H = (\sin h)\ l\ x$$

in which *H* represents the height; *h* the angular altitude above the horizon obtained by observing the kite with a surveyor's transit placed near the windlass; *l* is the length of the line from the reel to the kite read from the dial attached to the windlass (see Fig. 7); and *x* is a constant quantity determined experimentally as a correction for the sag of the line and for other incidental errors. If the kite is not visible, as, for example, during the night or when it is hidden by clouds during the day, the heights are taken from the barograph tracing, which is arranged to give heights graphically for the mean air temperature of 32° F. The accuracy of the registration of the line has already been referred to. The kites are so steady that the transit may be read to minutes of arc, though the readings are usually made to tenths of a degree (six minutes). The computation of height can be made in less than one minute, and the results are accurate within one per cent.

The objects to be attained by exploring the air with kites were first stated comprehensively by Archibald, of England, in 1882, and in 1883 he succeeded in elevating anemometers to a height of 1,500 feet. To William A. Eddy, however, is due the credit of having demonstrated to the scientific world the usefulness of the modern kite. Mr. Eddy has devised a very simple, efficient kite, which, together with an account of the first recording instrument elevated by a kite, was described in the SCIENTIFIC AMERICAN for September 15, 1894. At this time the greatest height reached by kites carrying instruments was less than 2,000 feet. Since 1894 the work at Blue Hill has advanced until within the past two years the meteorographs have been repeatedly carried to heights exceeding 10,000 feet. The greatest height—12,124 feet—was reached on August 26, 1898, and the average height attained during 1898 is about 8,000 feet. Compared with balloons, kites are much less expensive, are more easily handled—two men being sufficient for ordinary work—and, most important of all, the exposure of the instruments is probably equal to that of instruments at the ground—something impossible to obtain with instruments carried by balloons. Another great advantage is that the heights are controllable, and records may be obtained at any desired point up to over 12,000 feet. While the heights reached heretofore do not equal the highest balloon ascensions, the progress made so far warrants the belief that heights of 5,000 meters (nearly three miles) are possible.

The work at Blue Hill is under the general direction of Mr. A. Lawrence Rotch; Messrs. H. H. Clayton and A. E. Sweetland have charge of the reduction of the records; Mr. Clayton has attended to the design and construction of kites, while the writer has devised and constructed the windlass, meteorograph, and other mechanical accessories.

Blue Hill Meteorological Observatory,
December 15, 1898.

THE YUCCA PLANT IN VENEZUELA.

THE great staple of Venezuela is coffee, but as prices are low, farmers have been turning their attention to other plants which give a more lucrative return. Yucca, according to Consul Plumacher, of Maracaibo, appears to have a great future before it. It is a very productive plant, and although well known in Venezuela, no one as yet has taken any special care to develop it. One hectare (2·47 acres) of land upon which yucca is grown will produce 150 quintals (15,000 lb.) of starch, or 200 quintals (20,000 lb.) of tapioca. The plant is easily and cheaply cultivated. It will stand bad weather, and the dry season does not affect it, and it can be raised on any soil. The yucca will thrive on the same soil as pease, beans, and corn, and ground so utilized becomes far more remunerative than land planted with coffee. One hectare (2·47 acres) of tilled soil will produce 1,600 coffee plants. Allowing the maximum yield of coffee per plant, a hectare will produce 8 quintals (800 lb.) of coffee, and on the same ground the yucca will yield 150 quintals (1,500 lb.) of starch, exclusive of other crops from the same soil. The means of cultivation are primitive. Plows and other modern farming implements are almost unknown in Venezuela. All the work is done with old fashioned hoes, as neither man nor beasts have been trained to use modern plows.—Journal of the Society of Arts.

TOBACCO IN KOREA.

THE Koreans are great smokers, and both sexes and all classes begin smoking early in life and keep it up most diligently. Tobacco is not used by them in any other form than smoking. The pipe is the constant companion of every Korean man and woman. However poor an individual may be, there always seems to be some method of obtaining tobacco for the pipe which he or she is sure to possess, whatever else may be lacking. The tobacco used by Koreans is almost entirely home grown. Every farmer or gardener has his little patch of tobacco, much of which is very good in quality, but is injured in curing, being simply hung up under the wide eaves of the houses to dry. It is quite strong. The supply seems to be ample and the price is very low. No leaf tobacco is imported. According to the United States consul-general at Seoul, the Korean pipe is a brass bowl of fair size with a brass mouthpiece. These are connected by a hollow reed stem of from one to four feet in length, some of these stems being beautifully ornamented and all neat and light. The common people use shorter pipes for convenience in working, but all who can affect the long pipe both for coolness and for the appearance. The mouthpieces are often made of jade, amber, or other costly material, and of late mouthpieces of clouded glass have been offered for sale at such cheap rates as to make them more or less popular. The long pipe can be smoked with comfort only when the smoker is sitting down. Accidents often oc-

cur from persons falling with a long pipe in the mouth, the stem of which is driven down the throat, through the cheek, or into the soft palate. During the reform period that followed the Japan-China war, an order was issued forbidding the use of the long pipe by the common people. Many short foreign pipes were sold thereafter, and the use of the cigarette became less common. This order is now practically a dead letter, and the long pipe is reinstated, but cigarettes have become so popular because of their convenience, that it is said they will probably never be given up, but will increase steadily in favor. Native cigarettes of the poorest quality are made and sold at a very cheap rate. American cigarettes are used exclusively at the palace, where large quantities are consumed. Some English cigarettes are now to be found in the shops, and Russian and Egyptian brands are kept for the consumption of the European population.—Journal of the Society of Arts.

FROM DJIBOUTI TO HARRAR.

THE first section of the railroad from Djibouti to Harrar has just been inaugurated, and we are glad to be able to present to our readers some of the first views taken along the route, borrowed, along with the following particulars, from Le Monde Illustré.

In the first place, we have the Djibouti station building, which assures the present service. This will not constitute the central pavilion of the terminus. It is used only temporarily, and will ultimately form part of a structure of which it will be the left wing. The trains will pass before the station, since it will not be a stopping point on account of the cars having to run out upon the jetty. The entire building will be provided with a vast internal court recalling that of the entrance of the castle of Versailles.

Djibouti is in the way of becoming a terminus of which the importance may prove incalculable. During the last year everything has undergone a transformation at this point unknown of old, and new structures have sprung up here as if by enchantment. New avenues, squares, and boulevards have been laid out, and nearly two hundred houses have been built. What will it be when Adis-Abeba, the capital of Ethiopia, is in direct and daily connection with the port of the future?

The maritime lines have established a large coal depot at Djibouti, and almost all steamships and all the French war vessels touch here. There is a constant movement and a progressive activity that leads to the opening of new industries; merchandise of an entirely new character is daily arriving; everything is becoming transformed; and everything is lending itself to the exigencies of civilization.

The concession of the railroads of Ethiopia, which had been accorded by Menelik to Messrs. Chefneux & Ilg, was reassigned to a French association called the Imperial Company of Ethiopian Railroads.

The system is to comprise a great intra-African line, which will connect the coast of the Red Sea or the Gulf of Aden with the Nile in passing through Harrar and the capital of Ethiopia, Adis-Abeba, which is situated in Choa.

The first trunk is now finished, and trains are running over the viaduct of Chebele. This viaduct is one of the largest pieces of work that has been constructed in Africa. Its total opening is 512 feet and the length of the metallic part 525. It consists of nine spans of 39 feet opening and of eight piers 19½ feet in width. This arrangement has permitted of the construction of all the spans in a similar manner and of rendering them interchangeable, and, on another hand, of facilitating the mounting and putting in place, this being a very important matter where it is a question of work to be done in a distant land. The viaduct is provided with a footway at one side of the track, which latter is of 3·28 foot gage.

The piers are all of the same type, and differ only in height. They are formed of four cross-braced truss frames, each resting upon masonry. Their respective heights are 23 feet for the two small ones, 41 for the intermediate one, and 62 for the five large ones.

The metallic part of this work, which is entirely of steel, weighs about 237,000 pounds. The construction of it required but two months.

The mounting was begun in the month of August and the inauguration took place on the 10th of last November, in the presence of a large number of Europeans who had come from Djibouti.

The line is divided into three great parts, work on which is to be prosecuted in succession: First section, from Djibouti to Harrar; second section, from Harrar to Adis-Abeba; third section, from Adis-Abeba to Kaffa and the White Nile.

At the present moment the section from Djibouti to Harrar is alone under way. The concession of it has been accorded for ninety-nine years. The company has a guarantee of 3,000,000 interest accorded by the Ethiopian government. This guarantee is applied to the first section. The receipt of it is assured by a levy of ten per cent. upon customs duties.

THE CHEBELÉ VIADUCT.

The Ethiopian government has conceded gratuitously to the company the land necessary for the establishment of the railroad, with the mines and water that it contains. The width of the zone thus included upon unoccupied land is 3,280 feet, only 50 of which are reserved for the line, permission being given to sell the rest or to improve it.

Five routes for entering Ethiopia by caravans now exist, but of all these there are but two that are short and advantageous, those of Zeilah and Djibouti. There could be no question of the first, because it is English, and, moreover, for the reason that it presents the inconvenience of necessitating a crossing of the arid and waterless desert of Monida and of then passing through a region overrun by brigands.

The line under construction runs directly to El-Bah, which will be the first important station. El-Bah, which is situated at 162 miles from Djibouti, will be the point of bifurcation for Harrar or Adis-Abeba.

The line that is to run toward the center of Ethiopia and its capital will continue on toward the west, while the branch from Harrar will take a southerly direction. This branch will be the most difficult section to construct, since, although the length is but 48 miles, the track will have to ascend to an altitude of 6,600 feet and afterward descend to 5,850. It is estimated that after the line reaches Adis Abeba, twenty-five hours will suffice to travel over the 465 miles that separate the capital of Ethiopia from the sea. This trip is now made by caravans in twenty-five days.

NATIVES EMPLOYED IN THE CONSTRUCTION OF THE TRACK.

THE DJIBOUTI STATION.

THE WATER PUMP.

Contrary to what is shown by atlases, Ethiopia (that is to say, the regions effectively submitted to Emperor Menelik) has an area of 463,200 square miles, and is inhabited by a population varying between 10,000,000 and 12,000,000 souls. The city of Harrar contains 40,000 inhabitants, and Adis-Abeba has more than 50,000. The country consists for the most part of high plateaux, the altitude of which varies between 3,608 and 9,840 feet. Owing to such elevation the climate is absolutely healthy, and the temperature moderate. At Harrar the mean temperature is 23°, and at Adis-Abeba 18°, the maximum and minimum not deviating much from such averages.

Owing to conditions so favorable, and to the nature of the soil, which is everywhere cultivable, the latter is exceedingly fertile. In the lowest parts it is possible to cultivate cotton, coffee, and all the plants that require the same climate. In the more elevated parts all the cereals and other seeds capable of affording food for man and beast grow perfectly, and demand but a minimum of manual labor, while magnificent pasturages permit of cheaply raising all the live stock used as food in Europe, as also horses, asses, and mules.

Ethiopia, therefore, is undoubtedly a privileged country, and the only one of this nature in the whole of immense Africa, for the most fertile regions of which the people of Europe are so bitterly disputing with each other. Why, then, has it been able to resist the foreigner and preserve its autonomy? It is because it is inhabited by a people superior to the other autochthonous races of the greater part of the continent, and because this people, possessing a certain amount of civilization, and established in regions difficult of access, has been able to defend the latter, and appears to be in a condition to continue to make its liberty respected. Now, though it would be a great mistake to think of penetrating Ethiopia by brutal conquest, it seems indubitable that there would be a great advantage in conquering it pacifically in order to derive all the advantages that it is capable of giving, and which are very important. The words "conquering Ethiopia pacifically" mean to establish our influence therein, to help it develop itself economically and politically, and to reserve for ourselves all the benefits of easy and regular commercial and industrial relations. Such relations are extremely difficult at present, and the railroad alone will be able to develop them.

The transportation of a train of merchandise costs about a thousand francs. It may be said that at this moment there exists no industry which manufactures any one of the objects or products that are necessary for the life of the individuals. Although the land affords cereals and cattle, there are no mills for grinding flour, there is not a tannery for preparing skins, nor is there a single forge for manufacturing the most indispensable tools.

The products most frequently imported are: Hardware, calicoes and cretonnes, haberdashery, hats, linen drapery, hosiery, and perfumery; all that is necessary for lighting, such as kerosene, candles, matches, etc.; alcoholic and other beverages, groceries, sugar, rice, etc., and crockery, glassware, etc.

In order to give some idea as to how easy it is to sell products in Ethiopia, it will suffice to say that at this moment in Adis-Abeba people are paying one thaler (about 45 cents) for a small bottle of poor perfumery worth five cents in Paris, and the same price for an ordinary tumbler that sells for two or three cents in the last named city.

From our point of view, Abyssinia has, moreover, one very valuable quality, and that is a great facility of assimilation. To him who is acquainted with it there is no doubt that, if the exports that he may make yield him any returns, he will spend the profits for gratifying his taste for good living and luxury.

PORTABLE HAND-PUNCHING AND SHEARING MACHINES.

THE illustrations, Figs. 1, 2, and 3, given herewith, represent two ingenious portable appliances for shearing and punching joists, angles, tee and channel iron by manual labor. The construction of both these machines is simple. Their operations, it will be seen, are based upon the same mechanical principles. The section to be sheared is introduced between suitable upper and lower knives in the open space shown, and intense pressure is brought to bear upon it at the desired point by the upper cutter through the medium of the pressure bar, c^1, Fig. 2, and the system of levers, $g\ m^1\ m^2\ l$, the bar, c^1, being eccentrically pivoted, as shown. The cutters are supplied of different shapes to suit the section to be operated upon. Those shown shear one-half of the H section at one operation. The upper cutter, f^1, is lowered to its work by releasing a spring on the handle, f^4; the pressure bar, c^1, is brought to bear upon the cutter by releasing the lever, c^2, a wedge, b, being introduced to make a close fit.

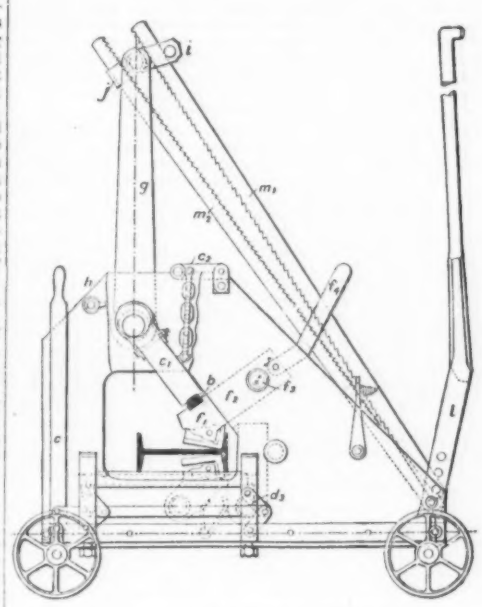


FIG. 2.—SHEARING MACHINE.

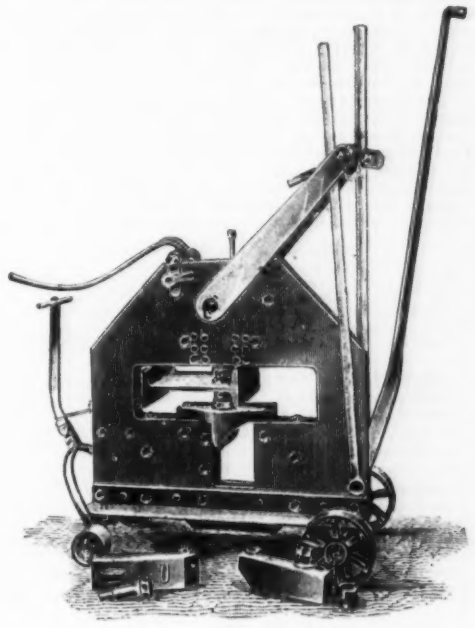


FIG. 3.—PUNCHING MACHINE.

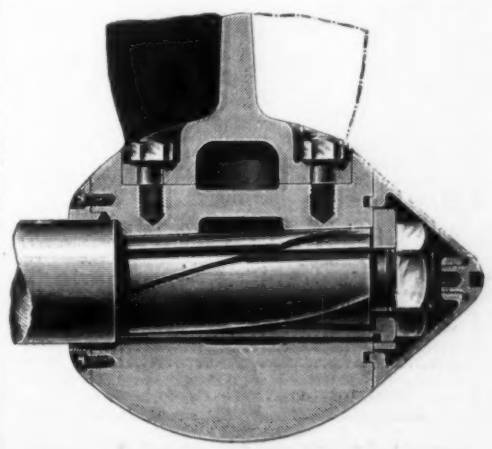
The lever, g, is next depressed to an oblique position, similar to that shown in Figs. 1 and 3, so as to bring pressure to bear upon the cutter. On the top of the lever, g, are two pawls, $i\ j$, which gear with the teeth of the ratchet levers, $m^1\ m^2$. The serrations on both these levers are of different sizes, the lever having the larger-sized teeth being used to depress the lever, g, by means of the hand lever, l, while the lever, m^2, serves to maintain the pressure on the article under operation, while the hand lever, l, is brought up again to its vertical position to start a fresh stroke. A roller support, shown in Figs. 1 and 2, is provided for raising and lowering the material to suit the cutters. Although it is claimed that a couple of men in cutting a 12 inch joist bring a pressure of 120 tons to bear upon it, the speed of working is not nearly so slow as might reasonably be expected. It will be observed that the leverage obtainable is very great. The engraving of the punching machine shows the dies arranged for making holes in the web of a joist. The essential features of the machine are similar to that above described. There must be many conditions where such appliances as these would be a boon to engineers, contractors, bridge and ship builders, and others. The machines, which are substantially made, are being introduced into Great Britain by Messrs. R. Becker & Company, Rivington Street, Curtain Road, London.—The Engineer.

FIG. 1.—HAND SHEARING MACHINE.

The ancients had a Suez Canal known to have existed as early as 600 B. C.

THE "BALLOT" SHAFT COUPLING AND PROPELLER.

THE accompanying figure, says The Electrician, illustrates a novel system of shaft coupling, the invention of Mr. John Ballot. The coupling is adapted for fixing in position driving pulleys, flywheels, main shafts, screw propellers, and for many purposes where a coupling is required which is secure in every direction and at the same time readily attachable and detachable. The shaft has formed upon it at the place where the pulley or flywheel is to be fixed three curved or cam-shaped projections, each of which extends in a helical longitudinal direction partly round the shaft. The one face of each of these projections is formed radial to the center of the shaft, while the other face is formed with a curvature. The boss of the pulley or flywheel is, on the other hand, formed with three correspondingly shaped grooves or recesses extending in the same helical direction. The projection and recesses consequently constitute an infinite series of a peculiar form of full and open screw threads of very steep or quick pitch, so that if the shaft be pushed longitudinally into the boss, it will pass in with a screw motion. It will be found, however, that the longitudinal motion can at any point be arrested, if, on holding the boss stationary, there be applied more or less suddenly to the shaft a force in the circumferential direction by which the curved surfaces of the projections will be firmly jammed or wedged against the corresponding curved surfaces of the recesses; and the frictional resistance to longitudinal motion produced by such jamming action will, with a sufficiently steep pitch of the screw, be greater than the force tending to produce a longitudinal motion. Thus, assuming the shaft to have been screwed into the boss of the pulley or flywheel until the helical projections of the former are situated entirely within the recesses of the latter, and the one part or the other then have a force applied to it in a circumferential direction so as to produce the beforementioned jamming action, the pulley will be firmly fixed on the shaft for transmitting power when rotated by the shaft in that direction. If, on the other hand, a force be applied to the one or the other part in the contrary circumferential direction, the jam of the curved surfaces will be released, and as the radial surfaces of projections will then bear against the radial surfaces of the recesses, a screwing action will be produced causing the pulley to be screwed longitudinally off the shaft. In order to enable the coupling to be employed for the transmission of rotary motion in either direction, longitudinal keyways are formed in the shaft



THE "BALLOT" SHAFT COUPLING AND PROPELLER.

and in the boss in such positions that when the curved surfaces fit tightly against each other, as described, the grooves will be exactly opposite each other, so that keys can be inserted into them; but these keys will not be subject to the total strain exerted.

MEMORANDUM ON THE MINERAL RESOURCES OF THE PHILIPPINE ISLANDS.*

By GEORGE F. BECKER.

THIS brief memorandum probably covers all the main discoveries in the geology of the Philippines which are of economic interest. It is drawn up from data recorded in the Spanish Mining Bureau (Inspeccion de Minas) but not published, manuscript mine reports by the late William Ashburner, verbal information obtained in Manila, and various technical publications of Semper, Santos, Roth, Drasche, Abella, and others.

Only about a score of the islands are known to contain deposits of valuable minerals. These are arranged below in the order of their latitude, to give an idea of their geographical distribution and to facilitate finding the islands on the map. The latitude of the northern end of each is taken as that of the island. The character of the valuable minerals stated in the table will afford a general notion of the resources of the islands.

Mineral-bearing islands and their resources.

Island	Latitude (north end)	Character of mineral resources.
	° ′	
Luson	18 40	Coal, gold, copper, lead, iron, sulphur, marble, kaolin.
Catanduanes	14 8	Gold.
Marinduque	13 34	Lead, silver.
Mindoro	13 32	Coal, gold, copper.
Carraray	13 21	Coal.
Batan	13 19	Do.
Rapu-Rapu	13 15	Do.
Masbate	13 37	Coal, copper.
Romblon	13 37	Marble.
Sámar	13 36	Coal, gold.

Island.	Latitude (north end)	Character of mineral resources.
	° ′	
Sibuyan	12 30	Gold.
Semirara	12 7	Coal.
Panay	11 56	Coal, oil, gas, gold, copper, iron, mercury (?).
Biliran	11 43	Sulphur.
Leyte	11 35	Coal, oil, mercury (?).
Cebú	11 17	Coal, oil, gas, gold, lead, silver, iron.
Negros	11 5	Coal.
Bohol	10 10	Gold.
Panaon	10 10	Do.
Mindanao	9 50	Coal, gold, copper, platinum.
Sulú Archipelago	6 30	Pearls.

The distribution of each mineral or metal may now be sketched in somewhat greater detail. In many cases the information given in this abstract is exhaustive, so far as the available material is concerned. The coal fields of Cebú, however, have been studied in some detail by Mr. Abella, and in a few other instances more extended information has been condensed for the present purpose.

COAL.

So far as is definitely known, the coal of the Philippine Islands is all of Tertiary age, and might better be characterized as a highly carbonized lignite. It is analogous to the Japanese coal and to that of Washington, but not to the Welsh or Pennsylvania coals. Such lignites usually contain considerable combined water (8 to 18 per cent.) and bear transportation ill. They are also apt to contain much sulphur, as iron pyrite, rendering them subject to spontaneous combustion and injurious to boiler plates. Nevertheless, when pyritous seams are avoided and the lignite is properly handled it forms a valuable fuel, especially for local consumption. In these islands it would appear that the native coal might supplant English or Australian coal for most purposes. Lignite is widely distributed in the archipelago; some of the seams are of excellent width, and the quality of certain of them is high for fuel in this class.

Coal exists in various provinces of the island of Luzon (Abra, Camarines, Bataan, Sorsogon). The finest beds thus far discovered appear to be those in the small island of Batan, lying to the east of the southern portion of Luzon, in latitude 13° 19′. These seams vary from 2 feet 6 inches to 14 feet 8 inches in thickness. Analyses have been made in the laboratory of the Inspeccion de Minas, and the mean of seven analyses gives the following composition:

Analysis of coal from Batan, one of the Philippine Islands.

Constituent.	Per cent.
Water	13.52
Volatile matter	37.46
Fixed carbon	44.46
Ash	4.56
Total	100

One pound of this coal will convert 6·25 pounds of water at 40° C. into steam at 100° C. The heating effect is about three-fourths that of Cardiff coal. The same beds are known to exist in other small adjacent islands, Carraray and Rapu-Rapu. A number of concessions for coal mining have also been granted on the main island of Luzon just south of Batan, at the town Bacon. No doubt the beds here are either identical or at least closely associated with the coal seams in the little islands.

The coal field of southern Luzon is said to extend across the strait of San Bernardino into the northern portion of Sámar. Here coal is reported at half a dozen localities, but I have been able to ascertain no details as to the thickness or quality.

In Mindoro there are large deposits of coal in the extreme southern portion (Bulacao) and on the small adjacent island of Semirara. This fuel is said to be similar to that of Batan.

The islands of Masbate and Panay contain coal, the deposits of which thus far discovered do not seem of much importance. Specimens from the southwestern portion of Leyte, analyzed in the laboratory of the Inspeccion de Minas, are of remarkably high quality, but nothing definite about the deposit is known to me.

The first discovery of coal in the archipelago was made in the island of Cebú in 1827. Since then lignitic beds have been found on the island at a great variety of points. The most important croppings are on the eastern slope, within some 15 or 20 miles of the capital, also named Cebú. Though a considerable amount of coal has been extracted here, the industry has not been a profitable one hitherto. This is, at least in part, due to crude methods of transportation. It is said, however, that the seams are often badly faulted.

At Uling, about 10 miles west of the capital, the seams reach a maximum thickness of 15½ feet. Ten analyses of Cebú coal are at my disposal. They indicate a fuel with about two-thirds the calorific effect of Cardiff coal, and with only about 4 per cent. ash. Large quantities of the coal might, I suspect, contain a higher percentage of ash.

The island of Negros is nearly parallel with Cebú, and appears to be of similar geological constitution, but it has been little explored and little of it seems to have been reduced to subjection by the Spaniards. There are known to be deposits of coal at Calatrava, on the east coast of Negros, and it is believed that they are of important extent. In the great island of Mindanao coal is known to occur at eight different localities, but no detailed examinations of any kind appear to have been made. Seven of these localities are on the east coast of Mindanao and the adjacent small islands. They indicate the presence of lignite from one end of the coast to the other. The eighth locality is in the western province called Zamboanga, on the Gulf of Sibuguey.

PETROLEUM.

In the island of Cebú petroleum has been found associated with coal at Toledo, on the west coast, where a concession has been granted. It is also reported from Asturias, to the north of Toledo, on the same coast, and from Alegria, to the south. Natural gas is said to exist in the Cebú coal fields. On Panay, too, oil is reported at Janinay, in the province of Iloilo, and gas is reported from the same island. Petroleum highly charged with paraffin is also found on Leyte, at a point about 4 miles from Villaba, a town on the west coast.

GOLD.

Gold is found at a vast number of localities in the archipelago, from northern Luzon to central Mindanao. In most cases the gold is detrital, and is found either in existing watercourses or in stream deposits now deserted by the current. These last are called "aluviones" by the Spaniards. It is said that in Mindanao some of the gravels are in an elevated position and adapted to hydraulic mining. There are no data at hand which indicate decisively the value of any of the placers. They are washed by natives, largely with cocoanut shells for pans, though the batea is also in use.

In the province of Abra, at the northern end of Luzon, there are placers, and the gravel of the river Abra is auriferous. In Lepanto there are gold quartz veins as well as gravels. Gold is obtained in this province close to the copper mines. In Benguet the gravels of the river Agno carry gold. There is also gold in the province of Bontoc and in Nueva Ecija. The most important of the auriferous provinces is Camarines Norte. Here the townships of Mambulao, Paracale, and Labo are especially well known as gold-producing localities. Mr. Drasche, a well known German geologist, says that there were 700 natives at work on the rich quartz veins of this place at the time of his visit, about twenty-five years ago. At Paracale there are parallel quartz veins in granite, one of which is 20 feet in width and contains a chute in which the ore is said to assay 38 ounces of gold to the ton. One may suspect that this assay hardly represented an average sample. Besides the localities mentioned, many others in this province have been worked by the natives.

The islands of Mindoro, Catanduanes, Sibuyan, Sámar, Panay, Cebú, and Bohol are reported to contain gold, but no exact data are accessible.

At the south end of the small island of Panaon, which is just to the south of Leyte, there are gold-quartz veins, one of which has been worked to some extent. It is 6 feet in thickness and has yielded from $6 to $7 per ton.

In the island of Mindanao there are two known gold-bearing districts. One of these is in the province of Surigao, where Placer and other townships show gravels and veins. The second district is in the province of Misamis. Near the settlement of Imponan, on the Gulf of Macajalar, there are said to be many square kilometers of gravels carrying large quantities of gold with which is associated platinum. The product of this district was estimated some years since at 150 ounces per month, all extracted by natives with bateas or cocoanut-shell dishes.

COPPER.

Copper ores are reported from a great number of localities in the Philippines. They are said to occur in the following islands: Luzon (provinces of Lepanto, Benguet, and Camarines), Mindoro, Capul,* Masbate, Panay (province of Antique), and Mindanao (province of Surigao). Many of these occurrences are probably unimportant. The great island of Mindanao, being practically unexplored, is full of possibilities, but as yet no important copper deposit is known to exist there. An attempt was made to work the deposit in Masbate, but no success seems to have been attained. On the other hand, northern Luzon contains a copper region which is unquestionably valuable. The best-known portion of this region lies about Mount Datá, a peak given as "2,500 meters ?" in height, lying in latitude 16° 53′, longitude 120° 58′ east of Greenwich, or 124° 38′ east of Madrid. The range of which Datá forms one peak trends due north to Cape Lacay-Lacay, and forms a boundary for all the provinces infringing upon it.

Datá itself lies in the province of Lepanto. In this range copper ore has been smelted by the natives from time immemorial and before Magellan discovered the Philippines. The process is a complicated one, based on the same principles as the method of smelting sulphosalts of this metal in Europe and America. It consists in alternate partial roasting and reduction to "matte" and eventually to black copper. It is generally believed that this process must have been introduced from China or Japan. It is practiced only by one peculiar tribe of natives, the Igorrotes, who are remarkable in many ways.

Vague reports and the routes by which copper smelted by natives comes to market indicate that there are copper mines in various portions of the Cordillera Central, but the only deposits which have been examined with any care are those at Mancayan (about 5 miles west of Mount Datá), and two or three other localities within a few miles of Mancayan. The deposits of Mancayan are described as veins of rich ore, reaching 7 meters in width and arranged in groups. Mean assays are said to show over 16 per cent. of copper, mainly as tetrahedrite and allied ores. The gangue is quartz. The country rock is described as a large quartzite lens embedded in a great mass of trachyte. An attempt has been made by white men to work these deposits, but with no considerable success. The failure does not seem to have been due to the quality or quantity of ore found.

LEAD AND SILVER.

A lead mine has been pratially developed near the town of Cebú, on the island of the same name.

The most important deposit of argentiferous galena is said to be at Torrijos, on the small island of Marinduque (latitude 13° 34′). A metric ton, or 1,000 kilogrammes, is said to contain 96 grammes of silver, 6 grammes of gold, and 565·5 kilogrammes of lead.

In Camarines, a province of Luzon, lead ores occur, but are worked only for the gold they contain.

IRON.

There is iron ore in abundance in Luzon, Caraballo,* Cebú, Panay, and doubtless in other islands. In Luzon it is found in the provinces of Laguna, Pampanga, and Camarines Norte, but principally in Bulacan. The finest deposits are in the last named province, near a small settlement named Camachin, which lies in latitude 15° 7′ and longitude 124° 47′ east of Madrid. A small industry exists here, wrought iron being produced in a sort of bloomery and manufactured into plowshares. The process has not been described in detail, so far as I know. It would appear that charcoal pig iron might be produced to some advantage in this region. The lignites of the archipelago are probably unsuitable for iron blast furnaces.

QUICKSILVER.

Rumors of the occurrence of this metal in Panay and Leyte have failed of verification. Accidental losses of this metal by prospectors or surveyors sometimes lead to reports of the discovery of deposits, and ochers are not seldom mistaken for impure cinnabar.

NON-METALLIC SUBSTANCES.

Sulphur deposits abound about active and extinct volcanoes in the Philippines. In Luzon the principal sulphur deposits are at Daclan, in the province of Benguet, and at Colasi, in Camarines. The finest deposit in the archipelago is said to be on the little island of Biliran, which lies to the northwest of Leyte.

Marble of fine quality occurs on the small island of Romblon (latitude 12° 37′). It is much employed in churches in Manila for baptismal fonts and other purposes. Marbles are also quarried at Montalban, in the province of Manila, and at Binangonan, in the province of Marong.

There are concessions for mining kaolin at Los Baños, in Laguna Province.

Pearl fisheries exists in the Sulú Archipelago and are said to form an important source of wealth.

* Extract from the Nineteenth Annual Report of the Geological Survey, 1897-98, part vi., Mineral Resources of the United States, calendar year 1897.

* I am unable to find this island, which probably is a very small one.

* I have not found this island on the map.

ARTIFICIAL SILK IN GERMANY.

ARTIFICIAL silk consists of prepared cotton or wool fiber, and has been known to the trade under this denomination for some years. It possesses an extremely silky luster and can therefore be employed as an imitation of silk. Count Chardonnet, a Frenchman, the inventor of this material, converted the cellulose (cotton or purified wool fiber) by a process described in German letters patent of the year 1884, through nitro-sulphuric acid into nitro-cellulose. He then freed the same from the acid and dissolved it in a mixture of alcohol and ether. The solution thus obtained, collodion is pumped through glass pipes which are provided with extremely fine holes, and these collodion threads are passed through warm water (acidulated), which causes the alcohol and ether to evaporate, and only the fine nitro-cellulose threads remain. A number of these fine threads are brought together, slightly twisted and spooled. The United States consul at Barmen says that this extremely lustrous, but easily inflammatory—even explosive—tissue was put on the market at the time of the Paris exhibition in 1889. Owing to its great liability to catch fire, it did not come into practical use, but after this difficulty was overcome by removing the nitro groups (a process called denitrating), the harmless fiber was employed in the textile industry. By a similar method artificial silk was produced by a chemist of Augsburg, Dr. Lehner. Lastly, however, a method has been invented in which the use of the injurious nitro-cellulose is omitted. Cotton waste is dissolved in copper oxide of ammonia and the solution is pumped through fine tubes. The delicate threads are passed through diluted acid, which separates the copper and ammonia, the result being an extremely fine lustrous fiber which is employed as an imitation silk. This process, says The Journal of the Society of Arts, which is patented in Germany and other countries, is said to have the following great advantages over those of Chardonnet and Lehner: (1) That the manufacture as well as the product is in no way dangerous; (2) that the production is much simpler; and (3) as a consequence imitation silk can be manufactured by this process at considerably less cost.

ENGINEERING NOTES.

In view of the fact that the supply of wood in the regions traversed by the railway in Western and Central Siberia is becoming gradually exhausted, the Imperial Ministry of Ways and Communications has resolved that the town of Sudshenski, in Central Siberia, shall be connected by railway with the Great Siberian Railway, for the purpose of supplying the latter with fuel. The coal mining industry has already been established at Sudshenski, as there are good beds of coal at that place.

The returns of the British Board of Trade show a great number of casualties in the United Kingdom for the nine months of 1898 ending September 30. Accidents to trains, rolling stock, track, etc., caused the death of 27 persons and injury to 565 persons. From other causes, carelessness, etc., 482 persons were killed and 1,110 injured; 98 of the killed and 865 of the injured being passengers. Of this number, 17 were killed and 75 injured by falling between cars and platforms; 27 were killed and 54 injured by falling out of the cars while in motion; 97 persons committed suicide on the railways, while 13 were injured while apparently attempting suicide, and the remainder of the fatalities and casualties were due to several causes, trespassing, etc. Other accidents in addition to these resulted in 358 deaths and 2,835 cases of injury to railway companies' and contractors' employés.

The locomotive building industry in 1898 showed the effect of the improved condition of business in that year as compared with the four preceding years. The contracting locomotive shops (not including the railroad shops), according to The Railroad Gazette, built 1,875 locomotives in 1898, which was 624 more than in 1897. The number of locomotives exported was 386 in 1897 and 554 in 1898. The following table shows the yearly output of locomotive builders since 1888:

1888	2,180	1894	695
1889	1,860	1895	1,101
1890	2,240	1896	1,175
1891	2,165	1897	1,251
1892	2,012	1898	1,875
1893	2,011		

Serious damage to rails on the Wabash Railway by hauling a disconnected engine at a speed of about 40 miles per hour is reported in The Railway and Engineering Review. Ten rails were broken and 772 were so badly surface-bent as to require their removal. The rail weighed 63 pounds per yard and the driving wheels of the engine were 56 inches in diameter. The road has a rule limiting the speed of disconnected engines to 20 miles per hour.

Most brass founders know that by the addition of a certain quantity of phosphorus to copper they are able to make a sound copper casting, but it is not every brass founder that knows the best way in which to mix this phosphorus in the copper. Phosphorus being such an extremely combustible substance, it hardly touches the molten metal before it ignites and is lost in flame and smoke. To get the full effects of the phosphorus, it has to be quickly plunged to the bottom of the crucible. An ingenious method practiced by a New York city founder is to take a very small crucible and bore several openings in it. The phosphorus is then put into this small pot, and the top is then covered over and a piece of paper wound around the bottom where the pot has been punctured. When the copper has the right heat, the founder takes the small pot and plunges it quickly to the bottom of the crucible. Of course the paper is immediately burnt, which leaves an opening for the phosphorus, and it, having but one way to escape, runs out through the small holes, mixes thoroughly with the molten mass and phosphorizes the copper. The metal is then ready for pouring, and with this treatment a sound copper casting can be made. Such a method of adding phosphorus to copper is especially good when the metal is to be cast for electrical purposes.

We are indebted to T. Hodgson, of Bedford, Province of Quebec, for a description of a natural dry dock and the manner in which it has been utilized, says The Engineering News. This dock is on the Maine side of the St. Croix River, between Calais and Passamaquoddy Bay. At this point a small brook has cut a channel of sufficient width through the river bank down to about the level of low tide, the difference in tide levels at this place being nearly 25 feet. As there was a considerable amount of shipping owned in this neighborhood and docking facilities were absent, some ingenious Yankee concluded that he would utilize the cut made by the small stream, especially as the high range of tide provided all the appliances needed to fill and empty the dry dock. Starting several hundred feet from the river, on the small tributary, a cut was made across the bed of the stream, extending into each bank, and a 10-foot wall of stone laid in cement was built. At the center opening the top of this wall was about on the level of the bed of the stream, but at the sides it extended above the highest tide. Sills were laid in the opening and a pair of ordinary lock gates were put in place, opening outward. A pipe controlled by a valve was laid in the center wall, level with the stream bed, and carried off any water intercepted by the low walls and the sills, and a ditch, cut above the level of high tide, provided an outlet for the small amount of water usually coming down the brook channel. A few well bedded cross timbers for supporting the keel of the vessel completed this serviceable dry dock. The operation of the dock was very simple. The vessel came up the river on the flood tide and was hauled into the dock and held in position over the keel blocks as the tide ran out. As the water level lowered, shores from the banks kept the vessel upright, and these are found sufficient for the class of vessel using this dock. When the tides had run out the gates were shut and the water was kept out until repairs were completed. To undock the ship the gates can be opened at low tide and the water thus admitted on the rise of the tide will float the vessel, and she can pass out and down stream on the ebb tide. This dock has been in successful operation for some years, and is an interesting example of the utilization of existing natural conditions for securing a much needed convenience.

MISCELLANEOUS NOTES.

The adulteration of lamp oils seems to be on the increase, and until a law is passed establishing a certain standard the worst oils will be used, not because of their inferiority, but on account of their cheapness. Unfortunately, many miners demand oils of the lowest price, utterly reckless of the dangers attendant upon the use of low grade oils. All efforts to induce miners to use only the higher grade of oils are fruitless in the absence of a law fixing a legal standard.—Report of the Mine Inspector of Tennessee for 1897.

Fire Commissioner Scannell, of New York city, intends to ask the Legislature to amend the city charter in the matter of penalties for chimney fires. At present, when a chimney fire is reported to Inspector of Combustibles Murray, the occupant of the apartment in which the fire occurred is prosecuted and fined. In hundreds of these cases, it is said, the tenants are too poor to pay the amount, and it has been found also that in most cases the owners of buildings are responsible for the unclean condition of the chimneys, and not the occupants. A measure fixing the penalty for a chimney fire at $35 and placing the responsibility on owners instead of tenants will be introduced in the Senate and the Assembly by a Republican and a Democrat, the bill being regarded by the fire department as a necessity.

Linstow reports the following case: A young man cut one of his fingers with a piece of glass. The wound healed without suppuration. Soon the patient felt a pricking sensation whenever the scar was pressed. This pricking not having ceased after several months had passed, he applied again for advice, believing that a piece of glass had become embedded in the flesh; so a Roentgen picture of the finger was taken, and in the lower part of the third finger a small right-angled figure was found to be visible. The picture being placed by the side of the patient's finger, the author made an incision in the affected location, and felt the knife grate against some hard body, which was then extracted with the forceps, and proved to be two tiny splinters of glass which had rested together at right angles.

The natural gas supply of Indiana has diminished to such a point that its early exhaustion is imminent, unless steps are taken to reduce the draught upon the wells, says Engineering News. The question is again coming up, therefore, as to whether the piping of gas outside the State cannot be stopped. When the pipe line to Chicago was first projected, in 1889, the Legislature passed a law prohibiting it, but the courts decided that the law was unconstitutional, it being in restriction of interstate commerce. Besides the Chicago pipe line, lines have been built which supply gas to fourteen cities and eighteen towns and villages in Ohio, including the once famous natural gas town of Findlay. A conference of men interested in the future of the gas fields was held at Muncie on January 19, to consider some action against the pipe lines. It was decided to ask the courts to enforce a law, passed by the legislature in 1891, forbidding the carrying of over 300 pounds per square inch pressure at any point in a gas pipe line. It is said that the Ohio Pipe Line Company carries a pressure of 755 to 1,000 pounds and the Chicago lines 600 pounds at the pumps.

The Metropolitan Street Railway Company is pushing the construction of its new power house, at Twenty-fourth Street and Thirteenth Avenue, in which air is to be compressed for use as motive power on the Twenty-eighth Street and Twenty-ninth Street crosstown line, but all information as to the progress of the work of installing the compressed air plant is refused, and no visitors are admitted to the building. Adjoining the power house in Twenty-fourth Street, and extending to Eleventh Avenue, are the new car barns, which, it is reported, are to house forty cars. Each car will be equipped with a motor, comprising a cylinder and piston with a crank attachment to the wheels. The air is to be carried in cylindrical steel "bottles," from 3 to 8 feet long, which will be placed under the seats, and the air will be taken from these "bottles" at 2,200 pounds pressure and delivered by means of a reducing valve to the motor cylinder at 150 pounds pressure. The refilling of the "bottles," which is done by means of a hose attachment from the reservoir, it is said can be effected in less than one minute. It is expected that the line will be in operation with compressed air as the motive power by May 1.—New York Tribune.

Tarragona has its one marvel, the cathedral, as the cathedral has itself its marvel, the cloisters. Its façade, colored the brown of the earth and warmed with a tinge of almost ruddy gold, fills the whole space of sky at the end of the steep street by which one approaches it, whose narrow lines indeed cut into the great rose window, and the arched Gothic portal, in which the Virgin and Child stand in the midst of prophets and apostles, carved simply and devoutly by the thirteenth century sculptor, who has set over them a Last Judgment in relief, crowded with small, indistinguishable dead, while the great saints—each saint distinct, with his written history beside him—rise visibly from their coffins, and two flying angels blow long trumpets above their heads. Walking round it, by ways which lose and find it again, we see the long, irregular, late Romanesque structure, like house added to house, with its low octagonal turret, exactly the deep, rich color of plum pudding. Inside, the church, with less of that properly Spanish mystery which we find in the cathedral at Barcelona, for example, has an ample dignity, and at night, before the altar candles are lit, becomes splendid in shadow. In its detail, in the gradual accumulation of structure and ornament, the statues of the retable, the windows, doorways, columns, it is in itself an almost complete historical museum of Spanish art in stone. But it is, after all, in the cloisters that one cares chiefly to linger. To walk there, looking between the slim white columns, with their history of the Bible or of the world carved minutely and with mediæval humor on the capitals; looking past them into that inner court where a garden of trees and shrubs blossoms with many greens—the green of palm, of cypress, of oleander; in that coolness under the sunshine visible upon the foliage, is to surrender one's self to an enchanted peace. Here Tarragona at least still sleeps perfectly, in that permanent dream of the middle ages. —Saturday Review.

SELECTED FORMULÆ.

An alloy of 63 parts iron and 37 parts nickel possesses a coefficient of expansion almost equal to nil. It is, therefore, well suited for fine tools, water pipes for kettles, etc.—Technische Notizen.

Detection of Water.—According to Brooks, the double iodide of lead and potassium, $PbI_2.2KI$, is a very delicate reagent for the presence of water, the double compound being resolved into its two constituent salts by the least trace of moisture. The double salt is prepared thus: Lead nitrate, 1 gramme, is dissolved in 10 cubic centimeters of water, and saturated potassium iodide solution is added as long as the precipitate at first formed continues to dissolve. The solution is then allowed to crystallize, after which the white crystals of the double salt which separate are collected, washed with absolute alcohol, and kept over quicklime.—Pharm. Zeit., xlii., 720.

Red Mordant for Bone.—Lay the finished articles for 15 to 20 minutes in nitric acid strongly diluted with water, rinse them off a little and place them in another vessel containing water with zinc protoxide (10 drops to a liter of water); stir frequently and leave the objects in it, whereupon they should be rinsed off again. Now put the pieces in a hot decoction of 30 grammes of yellow wood (fustic) in 1 liter of water and leave them in it for some time. Next add 1 gramme of carmine to 20 drops of spirit of sal ammoniac, allow to dissolve and add 30 grammes of soft water to this solution. After all has been stirred well, add another 1½ liters of water and immerse the articles. Now boil the solution and take out the pieces when they have attained the right shade.—Zeitschrift für Drechsler.

Indelible Laundry Inks.—The following, for use with a hand stamp, is taken from the Suddeutsche Apotheker Zeitung: Moisten 10 grm. dragon's blood and the same quantity of silver nitrate with a small quantity of distilled water. Rub well together, and add 10 grm. dextrin and sufficient glycerin to make the mass about the consistency of good printer's ink. Before applying the rubber stamp, apply a few drops of oil of sweet almonds to the face thereof, and rub it off with a rag. The best manner of inking the stamp is to rub the color into a bit of velvet and apply the stamp to it, instead of to the ink direct. The following are taken from the Pharmaceutische Zeitung. The inks may be used with either a pen or hand stamp.

A GOOD BLACK LAUNDRY INK.

	Parts.
Copper sulphate	35
Silver nitrate	15
Ammonia water	50
Potassium tartrate	10
Caustic soda	10
Dextrin	10
Sugar	5
Lampblack	1
Distilled water	80

Dissolve the copper sulphate in the ammonia water and add the silver nitrate in powder. Warm the water and add the soda and dextrin, and, when dissolved, stir in the lampblack. Mix the two solutions with persistent stirring.

ANOTHER BLACK INK.

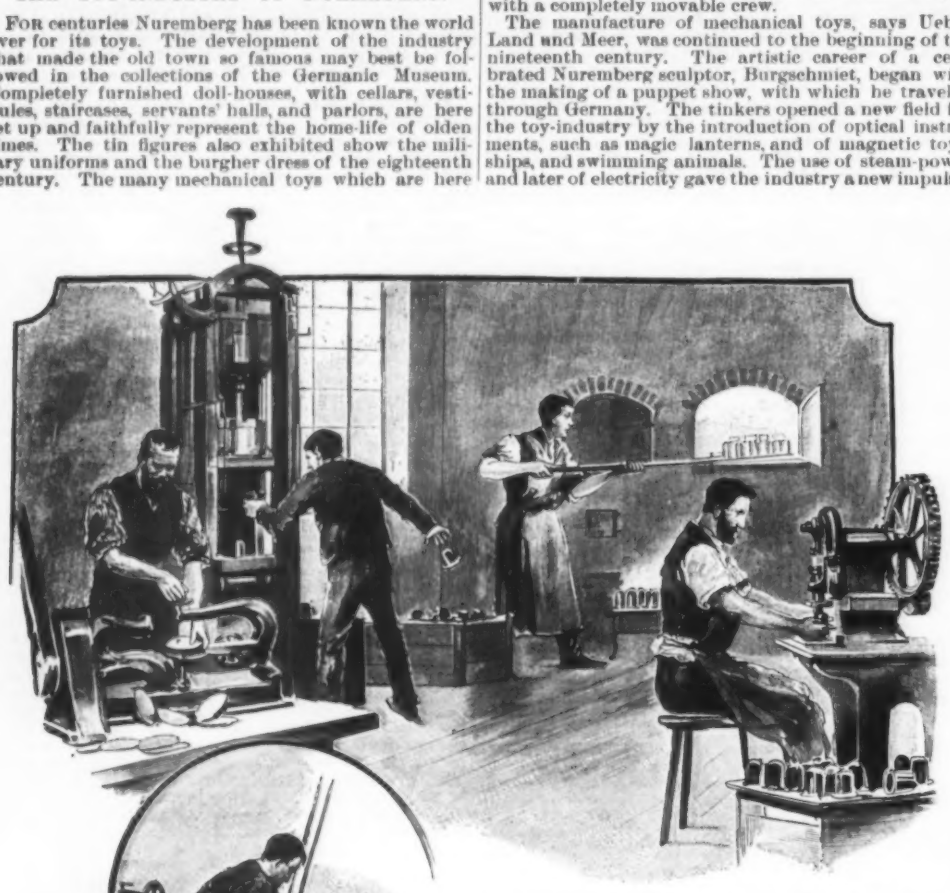
In 10 parts of ammonia water dissolve 5 parts of silver nitrate. In another vessel dissolve in 15 parts of distilled water 5 parts of caustic soda and 5 parts of gum arabic. Mix the solutions and let stand for one hour in a warm place. Fill into small bottles.—National Druggist.

A Certain Roach and Bedbug Destroyer.—Herr Bernegau deserves the thanks of all housekeepers and, in fact, of suffering humanity in general, for a long, exhaustive, and exact inquiry recently made by him in regard to the real work and value of those substances hitherto recommended and generally believed to be efficacious as roach and bedbug destroyers. The results are somewhat surprising and disappointing to those who for years have spent money and time daubing the bedsteads, etc., with the various bug killers, destroyers, eliminators, etc., of the market. Herr Bernegau's method of investigation was very practical and certain. The bugs were caught and kept in glass tubes, so that the effects could be most closely watched. The following is a brief resumé of results. Best fresh insect powder made the bugs a little groggy for a while, but they soon became as lively as ever and seemed to experience no evil results from the powder. When mixed with 10 per cent. naphthalin, a few of the bugs were killed, but results in general were poor. Various chemicals in powder form gave little better results. Hydrogen hyperoxide was a flat failure. Formalin acted well, but is too costly to be used, and besides, it has unpleasant effects on those who apply it. Coal oil was deadly, but aside from the unpleasant odor, there is the danger of fire—and so on through the line; if an article was efficient, there was sure to be some counter-indication to its use. Finally, Herr Bernegau tried turpentine oil alone and with naphthalin and found at last the true roach and bedbug destroyer. The following are his directions for freeing a locality—barracks, say—of the "terror that walketh in darkness:" All the furniture, the walls, the floor (the cracks and joints of which furnish favorite hiding places for the bugs), should be gone over with turpentine oil and naphthalin applied with a brush. The application, by its penetrating odor, chases the insects out of their hiding places into the open in thousands. A little sprinkling of the oil is sufficient to kill these. Immediately after having done this, with a hot solution of carbolic soap (to 2½ gallons of boiling water add a quart of liquid carbolic soap) wash the floors, baseboards, etc. To prepare the turpentine oil and naphthalin, proceed as follows: Into a half gallon jug pour a quart of oil of turpentine, add 150 grains of naphthalin, and set the jug in hot water, giving it several energetic shakes. To prepare the carbolic acid soap, heat together equal parts of common yellow potash soap and of commercial carbolic acid until a clear solution is obtained. After the turpentine and naphthalin have soaked into the walls, etc., the latter should be freshly painted or kalsomined.—Western Druggist.

THE TOY-INDUSTRY OF NUREMBERG.

For centuries Nuremberg has been known the world over for its toys. The development of the industry that made the old town so famous may best be followed in the collections of the Germanic Museum. Completely furnished doll-houses, with cellars, vestibules, staircases, servants' halls, and parlors, are here set up and faithfully represent the home-life of olden times. The tin figures also exhibited show the military uniforms and the burgher dress of the eighteenth century. The many mechanical toys which are here to be seen are the work of locksmiths; for, besides working at his trade, the Nuremberg locksmith made many a clever toy. The chronicler Johann Neudörfer, for example, narrates in his "Nachrichten von Nurnberger Künstlern und Werkleute" (Account of Nuremberg Artists and Artisans), written in 1547, that the locksmith Hans Bulmann had with great skill made many little movable figures by order of Emperor Ferdinand I. The chronicler further states that at the same time the locksmith Kaspar Werner had made for the Viennese Imperial Art-Chamber (Kunstkammer) a splendid ship, three-quarters of an ell in length, with a completely movable crew.

The manufacture of mechanical toys, says Ueber Land und Meer, was continued to the beginning of the nineteenth century. The artistic career of a celebrated Nuremberg sculptor, Burgschmiet, began with the making of a puppet show, with which he traveled through Germany. The tinkers opened a new field for the toy-industry by the introduction of optical instruments, such as magic lanterns, and of magnetic toys, ships, and swimming animals. The use of steam-power and later of electricity gave the industry a new impulse.



DRAWING, STAMPING, AND ANNEALING THE TOYS.

TURNING THE CYLINDERS.

SHEARING THE METAL.

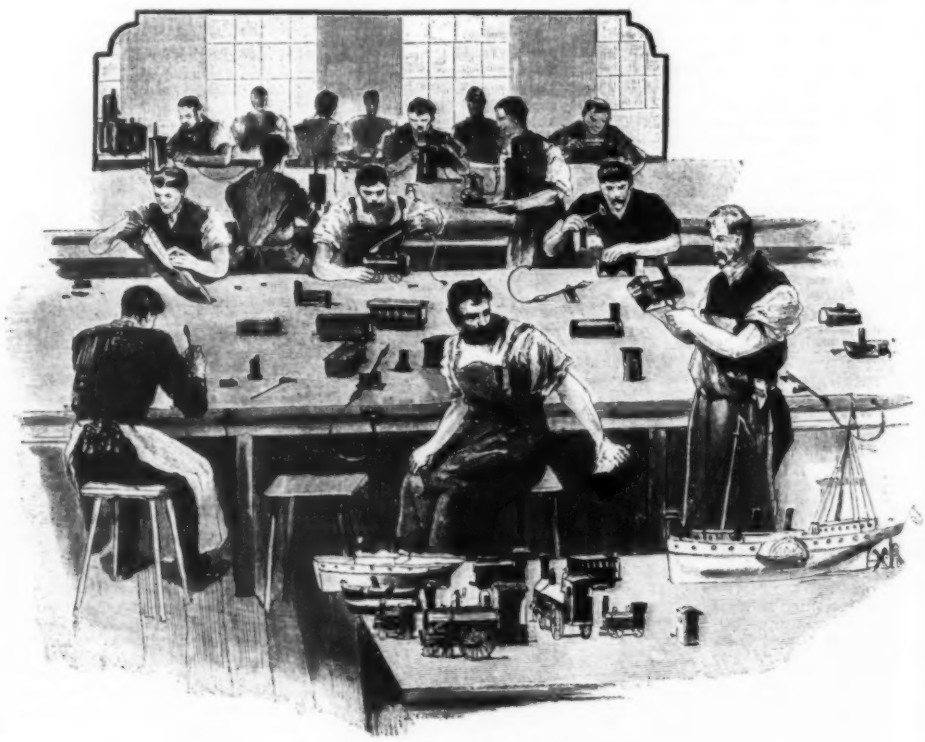
It may not perhaps be uninteresting to visit one of these vast toy-factories and to watch the various steps in the making of a toy.

The engine and motor room of the factory having been traversed, we first come to a hall in which large sheets of tin are cut by ingenious shearing-machines into the desired sizes. These pieces are taken into another room, where they are drawn or stamped into various forms by special machines. With but a single pressure of a stamping-machine a piece of metal is given any shape. The same work would, if done by hand, require a much longer time. As soon as the pieces have been stamped or "pressed," as it is called in technical parlance, they are put into an oven in order to be annealed, the object being to strengthen the forms. In order to remove the jagged exterior of the cylinders, the forms are taken to another room, turned and polished. The turner is, however, engaged not only in smoothing and polishing, but in cutting the threads of screws and in shaping the separate parts of each toy on his whirring lathe.

After all this preliminary work has been done the various parts are assembled by skilled workmen. With the utmost care each little piece is inspected and critically examined for the purpose of determining its strength and durability. Here we see a workman busily engaged in putting together the parts of a locomotive; after having completed this task he sets aside his work with a visibly satisfied air. Another workman is assembling the parts of a railway-coach; a third is building a steamship; and others are making chessmen, magic lanterns, small engines, phonographs, and the like. All the engines, especially those of the locomotives and steamships, are carefully tested before leaving the factory.

As soon as the toys have been tested they are taken to the varnishing room, there to be painted and japanned. As the paints dry very slowly, and as a merchant when ordering his wares often stipulates quick delivery, the toys are placed in ovens, and in this way quickly dried.

Many are the departments in a toy-factory which we could visit. We must, however, content ourselves with glancing in the room in which all the different varieties of toys made in this particular factory are exhibited. It is most difficult to know where to begin, for the number of objects to be seen is enormous. Here are exposed to view all possible kinds of magic lanterns, stereopticons and slides, all kinds of steam engines from the commonest sort to the finest models for school use. After these come beam-engines and locomotives with their coaches and passengers. Nor should we forget the toy fountains and other forms of water-apparatus. Ships form a class by themselves. Warships, passenger-steamers, steam-launches, yachts, and even lighthouses are exhibited. Motors of various forms can be seen in operation; and many are the pieces of experimental apparatus for frictional electricity, Morse telegraphs, induction coils, incandescent lamps, and phonographs exhibited in the electrical division. It should be remarked that all objects which are here made, in spite of the accuracy of their construction and scientific value, are essentially toys. But a child's play has a deeper signification than many may believe, or as the old saw has it: "Discimus dum ludere videmur."



ASSEMBLING THE PARTS OF THE TOYS.

SIBERIAN SILHOUETTES.

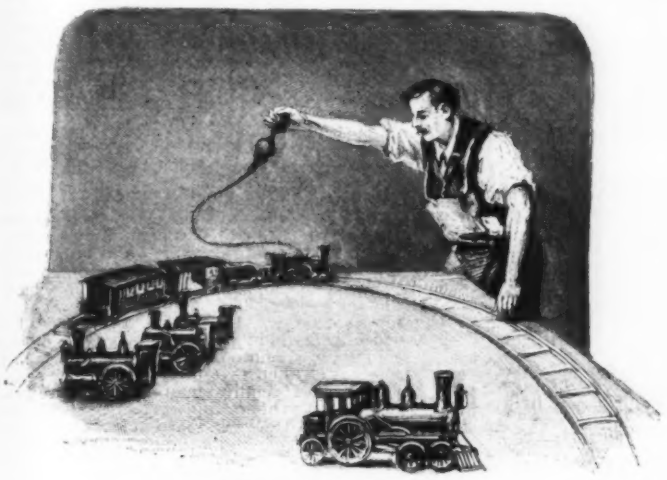
Although bears and wolves are plentiful in most districts, and splendid bear skins are to be bought for a few shillings in nearly every village, I had traveled some thousands of miles both in winter and summer before I saw my first live bear. I only saw three in five years, and the wolves I met I could number on my ten fingers. Yet I once waited six hours at a post house to rest the horses I had arrived with, as two of the troitka, that should have taken me to the next station, had been eaten by wolves that evening while drinking at a little stream just outside the village. The forests teem with life and food for the bears and wolves, and these animals seldom "take to the road" as a means of livelihood. While living at Yeniseisk I heard from an angler friend of a little tributary of the Great Yenisei where the grayling were rising fondly at the gnats and mosquitoes. Taking a few flies, a couple of strong silk lines and a hatchet to cut an impromptu rod or two, we set out in an old telega with a couple of horses one delightfully hot afternoon in June, to drive the twenty versts to the little forest stream. Shortly before reaching it, we stopped at a quiet little village inn. While the old mother handed us wooden bowls of kwass she said: "You will probably find 'Meesha' just by the bridge; he has taken to coming there lately to bask in the sun." We thought nothing of her words until upon galloping down a short steep hill we saw just below us, a hundred yards ahead, what at first appeared to be a brown cow or a large dog asleep in the middle of the road. Our driver cried: "There he is, the sudkinski! Hold tight, and when I cry out, shout your worst." He lashed his horses, which, with

their ears pricked forward, swerved from side to side of the road in a panic of fear. When we were within thirty yards of the bear, sweeping down like an avalanche, we commenced shouting and yelling, the driver cursing in explosive Russian "Michael," "his mother," and his race. The great beast sat up suddenly, blinked at us, and when we were within ten yards of him gave a loud snort and bounded up the side of the bank, where he sat slobbering and growling as we swept by, in a cloud of dust, on the opposite side of the road. A parting shriek sent him off crashing through the underwood. When we could pull up half a mile ahead, and the driver got down to adjust the rope harness, he cried: "Pardon my sins! but 'Meesha' can't endure my cursing." I felt a tingling excitement that made me break into long and loud laughter.

In Siberia murder is rarely punished by death; the criminal is only sent further east. If the crime is repeated, he is passed on to a distant and more inclement zone. Some convicts at the Lena mines were credited with being murderers to the fifth degree. The nurse of my motherless boy was an exile who had killed her husband. One lost the sharp sense of antipathy to the criminal so instinctive in the West. Robbery accompanied with murder is common enough. I saw four crosses on the road just as I entered Irkutsk, one of which marked the spot where ten people had been murdered in open daylight. At night robbers wrap themselves in white calico, and, invisible in the snow, cut the luggage from behind the sleighs. Near the mines a considerable trade in illicit spirits is carried on by the spiriti nocu, as the smugglers are called. These buy contraband vodki at Vitim and carry it into the mining districts, where they make a fabulous profit in exchange for stolen gold. They travel along obscure footpaths which cross the main road at well known points. These are notoriously dangerous spots, from the murders that take place near them. Travelers gallop swiftly by, peering anxiously around. Shafts of old disused mines hold ghastly secrets. I was told that over a hundred frozen corpses lay in some of these, and that the company is afraid to reopen them for fear of the scandals that would arise. Returning home one midnight from a distant mine, I rode toward a light in a dell, to find two mounted Cossacks keeping watch over the body of a man who had been murdered a few minutes before. Men are slain for a pair of boots or even for a passport. I repeatedly met or overtook bands of exiles going east, in slow loose order, guarded by Cossacks. Escapes are not infrequent, but they are made at a terrible risk. Days may pass by without food, and flies and mosquitoes are more deadly than wolves. Escaped convicts travel by night, and peasants frequently put food outside their huts for these poor runaways. Forged or stolen passports are carried, but many a man is detected or captured by slight errors in their preparation. The Cossacks have to deliver at their journey's end the exact number of convicts started with; and ghastly tales are told of peasants kidnapped to make up the number for those who have escaped en route. Once when I was traveling on a byroad with a governor of the district, he pointed out to me a ragged man as an "escaped." He covered him with his revolver and called the man to him, saying, "Show me your passport!" The man turned white and trembled. "Unbutton your coat!" shouted the officer. The man obeyed and fell on his knees. There were the polished iron chains that he had not been able to remove. The officer broke into a merciful laugh, and throwing him a piece of silver allowed him to escape.

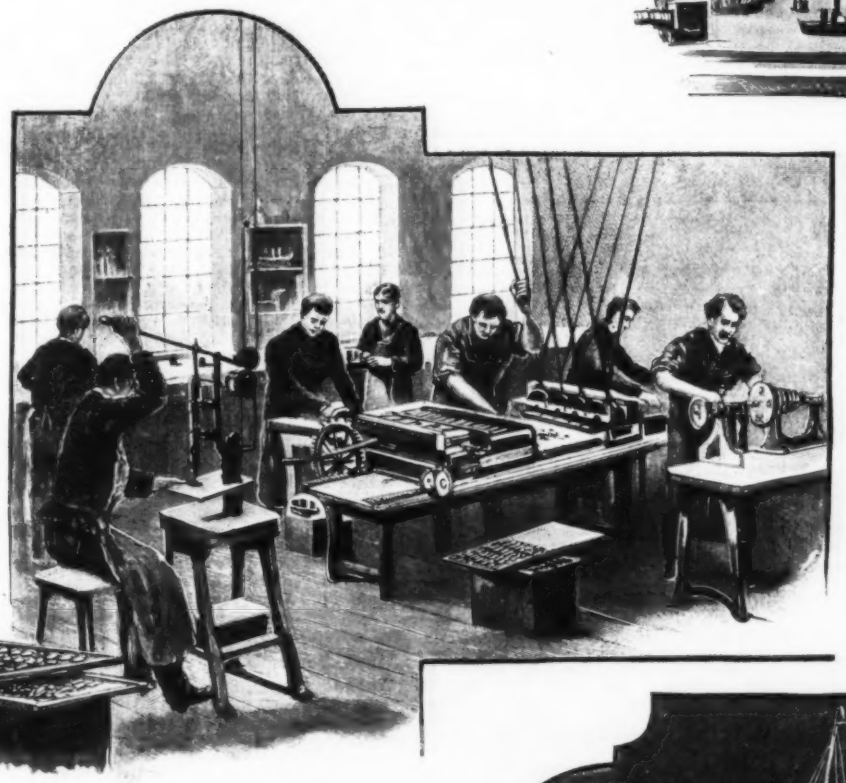
In Siberia the most naive and grotesque fetishism exists side by side with not a little western emancipation. More than once we met with the stone that was going on pilgrimage; a large round block of granite journeying to a distant shrine or monastery. The orthodox are entreated to roll it a few yards on the way as an act of piety. It will be years on the road, but it will arrive at last. In the museum of Tobolsk are relics of Ermsk, the discoverer of Siberia in A. D. 1581. Here are some of the weapons of torture of Ivan the Terrible; knouts with lead balls at the ends of the thongs, and branding irons for convicts' faces. On my way out I saw the exiled bell, which had been banished from Ooglitch two hundred and fifty years ago for ringing the alarm which nearly betrayed a conspiracy. It was publicly flogged and its hammer removed. On my return to Tobolsk the bell was gone. It had served its full time, and had been sent back to Ooglitch!

For five days we journeyed up the Lena. I bought a long gondola-like boat. All day three horses with a long tow-line drew us, while they waded through the shallows. Forests came down to the water's edge. The scenery was impressive but very lonely. One long day our troitka had been ridden by a boy and a girl of ten and eleven. At night we roped up, and I saw with amazement the two children start back again in the twilight, laughing as they splashed through the shallows without a shade of fear. But these memories are endless. There is witchcraft in them. I can never forget this amiable land or its hospitable people. A great calamity fell on me there; but the sympathy and inexpressible tenderness I met with will never fade from my memory while life lasts. I do not believe a nobler or more generous people exists in the world. I have been in the ice-bound tundras of the mouth of the Yenisei, on the Obi, the Lena, the Angara, and a score of other rivers; in Tomsk, Krasnoiarsk, and Irkutsk, and other cities; I do not say evil men are not to be found there. I only speak bare truth when I declare I met with nothing during five long years but good comradeship from men and gracious providence from women. I was never cheated, wronged, or betrayed by great or simple. May Siberia prosper!—E. Aspray, in Good Words.

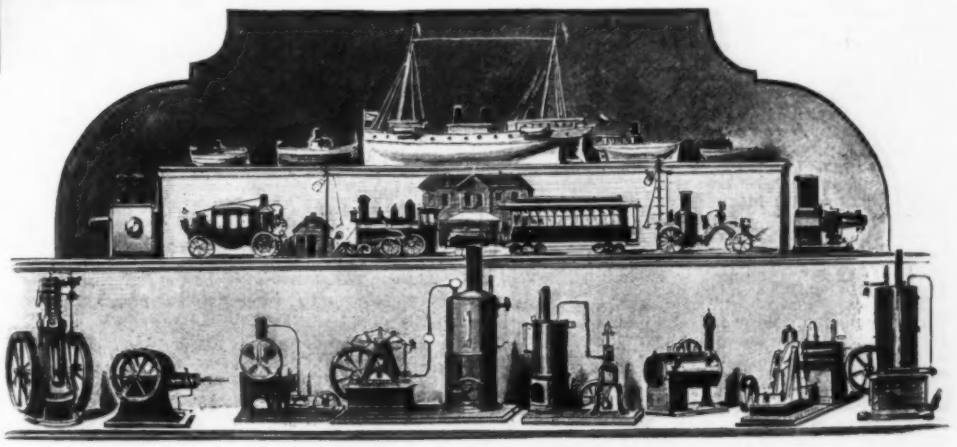


TESTING A LOCOMOTIVE.

VARNISHING-ROOM AND DRYING-OVENS.



SHAPING THE TOYS.



EXHIBITION OF COMPLETED WARES.

THE TOY-INDUSTRY OF NUREMBERG.

It is pointed out by Dr. Coleman Sellers that one of the most notable examples of ball bearings, now growing in vogue, is the diminishing of the friction of a collar sustaining the hooks of a large crane. Thus, by making the crane hooks with flat washers, between which numerous small balls are placed, resting upon hardened surfaces, there seems to be no difference between the friction of rest and the friction of motion, and hooks heavily loaded are turned with remarkable ease; in fact, the use of balls distributed over plane surfaces is becoming a settled practice, there being no basket or grooves to separate the balls, as the latter are allowed to move at their own tendency—that is, in whatever may be their inclination. As to the size of the balls adapted to different purposes, various experiments show interesting results. In the case of hooks for cranes carrying about 50 tons, between 250 and 300 balls, each of ¾-inch diameter, are scattered between the flat plates, on the assumption that the more points of contact, the more lasting the balls; but some tests made with balls of different sizes, and motion kept up under loads to determine their durability, favor larger balls and fewer of them.

ACETYLENE.*

By VIVIAN B. LEWES, Professor of Chemistry, Royal Naval College, Greenwich.

As I have before stated, it was in the autumn of 1894 that I first received a supply of American carbide, and in reporting on this material on November 26 of that year I wrote:

"This gas, when mixed with an equal quantity of air, can be burnt at a No. 4 Bray burner, and the illuminating power of the mixture would be equal to 65·7 candles per five cubic feet of gas consumed, which would give the acetylene an illuminating value of 131·4 candles per five cubic feet. The presence of an inert gas such as the nitrogen in the air is well known to exercise such a cooling power on the flame as to seriously reduce its illuminating value, and I find that if the acetylene be burnt by itself at a suitable burner, it develops no less than 330 candle power per five cubic feet of gas consumed."

Further experiments made during December, 1894, with carefully purified gas, yielded a slightly higher result, and in the paper read before this society in January, 1895, I gave the illuminating power of the gas when burnt under the best conditions as being 240 candles.

A considerable amount of vagueness exists as to what is meant by the illuminating value of a gas, and the only assumption which can be arrived at is that it is the highest illuminating effect which can be produced from the gas without the aid of regeneration or artificial air supply other than that created by the flame itself.

The proper combustion of any hydrocarbon gas, however rich, can be effected by supplying the flame with exactly the amount of air necessary to prevent smoking, and it is under these conditions that the highest illuminating effect possible with the particular burner is obtained.

With flat flames the ratio between the air supplied and the gas consumed is governed by two factors: (*a*) The thickness of the flame; (*b*) the pressure under which the gas issues from the burner.

When a gas issues from a burner under pressure, the uprush of the escaping gas mechanically draws in air, so that when consuming a poor coal gas in a flat flame the pressure has to be kept down, or too much air would be dragged in, which would consume the hydrocarbons too rapidly, and so seriously affect the amount of light emitted. As the gas increases in illuminating value, more and more air is required for proper combustion, and this can be obtained by increasing the pressure at the burner.

Experience has shown that with ordinary sized flat flame burners, seven-tenths of an inch in pressure gives practically the best results with coal gas of the quality supplied in London, and up to a certain limit the same flat flame burner can be used for richer gases by increasing the pressure. When this limit is reached, a thinner sheet of flame has to be employed, i. e., a smaller burner used, low initial pressure resorted to, and then by increasing pressure this can be made to consume gases of increasing value, until the pressure reaches a point at which the flame becomes distorted, when a still smaller burner has to be taken. By such means as these even acetylene, with its enormously high illuminating value, can be satisfactorily consumed while by thickening the flame and reducing the pressure to the point at which the uprush almost ceases to cause a mingling of air with the flame and leaves the supplying of the oxygen to diffusion, even a poor gas can be made to develop its illuminating power.

On consuming acetylene from a 000 union jet burner, at all ordinary pressures a smoky flame is obtained, but on increasing the pressure to four inches a magnificent flame results, free from smoke and developing an illuminating value of 240 candles per five cubic feet of gas consumed. Slightly higher values have been obtained, but 240 may be taken as the average value under these conditions.

This figure is the one quoted by most manufacturers of acetylene apparatus, who argue from it that acetylene is fifteen times as valuable in illuminating power volume for volume as London coal gas.

Such a comparison is, however, absolutely misleading, as in contrasting the value of acetylene with coal gas one must always bear in mind that the illuminating power of the London gas is determined by consuming it at the rate of 5 cubic feet per hour in the London argand, while in practice any power from 8 to 90 candles can be obtained from this volume, according to the form of burner in which it is consumed. Although small flat flame burners only emit from 1 to 2 candles per cubic feet of gas consumed, good incandescent mantles will yield about 18 candles per cubic foot, and certainly 17 on the average; and as incandescent gas lighting is rapidly displacing other methods of burning gas, and as this tendency will be enormously increased when the lapsing of the Welsbach monopoly reduces the price of the mantles to the figure now charged in Germany, it is evident that no calculation is fair that does not include this as a factor.

Moreover, a very short experience soon shows that burners consuming 1 cubic foot of acetylene per hour are the largest that can be practically used for domestic purposes, and that taking such burners all round 32 candles per cubic foot is a fair average of the light developed by them, although out of a big batch of burners you occasionally find a few which will go as high as 36 or even 40 candles per foot. The influence which the size of the burner and the rate of consumption has upon the illuminating power of coal gas is well known, and is shown in the following table:

Flat flame Burner.	Candles per cubic foot.
No. 7	2·44
„ 6	2·15
„ 5	1·87
„ 4	1·74
„ 3	1·63
„ 2	1·22
„ 1	0·85
„ 0	0·59

* Lecture IV.—Delivered December 19, 1898, before the Society of Arts and published in the Journal of the Society.

And as the consumption of acetylene is regulated by exactly the same factors as act in the case of coal gas, it is evident that the smaller the burner and consumption, the lower will be the candle power per foot of acetylene, and in practice with a one-half cubic foot burner 24 candles per cubic foot is a good result.

Taking a series of burners of the Naphey type, obtained from Falk Stadlmann & Co., the following results were obtained:

No. of burner.	Pressure.	Gas consumed.	Light.	Candles per foot.
	inches.	cubic feet	candles.	
6	2·0	·155	0·7938	5·3
8	2·0	·27	3·2	11·6
15	2·0	·40	8·0	20·0
25	2·0	·65	17·0	26·6
30	2·0	·70	23·0	32·85
40	2·0	1·00	34·0	34·0

From these considerations it is evident that the only fair way to contrast the light obtainable from coal gas and from acetylene is to take the incandescent burner on the one hand and the 1 cubic foot flat flame on the other, when it is seen that, instead of being fifteen times the value of the coal gas as an illuminant, it is only about twice its power. The acetylene burner, however, has one advantage over the mantle, and that is that you can more or less regulate the light to the amount you require.

When acetylene is burnt in air under such conditions as to complete its combustion, it is converted into carbon dioxide and water vapor, the same compounds as are produced by all combustible hydrocarbons.

$$2\,C_2H_2 + 5\,O_2 = 4\,CO_2 + 2\,H_2O$$

and 1 cubic foot of acetylene requires 2½ cubic feet of oxygen.

The researches of Dr. Grehant have shown us that when burning with a smokeless flame no carbon monoxide can be detected in the products emitted by its combustion, and its sanitary position will therefore be defined by the amount of oxygen abstracted from the air and carbon dioxide produced as compared with other illuminants.

Taking the average-sized room, which would be well lighted by an illumination equal to 64 standard candles, we find that this amount of light from various illuminants would have the following effect on the atmosphere:

Illuminant.	Oxygen removed from air.	Products of combustion.	
		Water vapour.	Carbon dioxide
	cub. ft.	cub. ft.	cub. ft.
Sperm candles	38·5	26·2	43·6
Paraffin oil	24·9	14·0	39·8
London gas—Batswing	26·1	29·4	19·2
Argand	23·0	25·6	17·0
Regenerative	10·6	8·3	5·2
Incandescent	3·1	4·6	1·8
Acetylene	5·0	2·0	4·0

So that light for light it fouls the air less than any of our ordinary illuminants, with the exception of the incandescent gas burner.

In comparing the heating effect of various illuminants on the air of a room, it is necessary to determine the calorific value of the combustion of a cubic foot of the illuminating gas employed, and it is manifest from theoretical considerations that a highly endothermic compound like acetylene must have a far higher heating power than ordinary coal gas. The mean of a number of experiments made in Junker's calorimeter gave as the thermal value of the ordinary London gas supply 158 calories, while under the same conditions acetylene yielded 320.

The theoretical amount of heat emitted by the combustion of a cubic foot of acetylene is 349·08 calories, but this would only be given by the absolutely pure and dried gas, and the experimental number determined in the calorimeter represents more truly the heating power of the moist gas under ordinary existing conditions.

Taking now the case in which a room is lit up with a power equal to 64 candles, we find that if we call the heating effect produced by an incandescent mantle giving this amount of illumination 100, then:

RATIO OF HEAT EMITTED TO YIELD A LIGHT OF SIXTY-FOUR CANDLES.

Incandescent mantle	100
Acetylene	115
London Argands	571
Flat flame burners	914

So that for all practical purposes the heating effect on the air by acetylene illumination is the same as with mantles.

When one comes to compare the cost of acetylene and coal gas, one is again struck with admiration at the statements made by the advocates of the former as a rival to the well established coal gas industry. At the present time the wholesale price of carbide is £20 a ton, but I believe that to fill large cash orders it can be obtained at £16 at Foyers, which would mean at least £20 a ton at the works where it is to be decomposed and the gas distributed. The decomposition of carbide is not a costly operation, but at least 10 per cent. would have to be added to the price of the carbide for handling, water, repairs, interest on plant, purification, etc., and this would bring the price of the acetylene to £2 per 1,000 in the holder. Coal gas in the holder, when made on the scale common in our big cities, costs, however, about 1s. 2d. per 1,000 in the holder, and about 100 per cent. has to be added to this to cover the charges of distribution and profit. The power of doing this is dependent on the amount of gas sold, and while the South Metropolitan can make a fair profit on gas at 2s. 3d. a 1,000, there are many small country works that cannot pay a dividend with gas at three times the price. With acetylene the smallness of the output would necessitate a heavy charge over cost price, and I should be surprised to find an installation of acetylene even in a fair sized town paying its way with a less charge than £3 per 1,000.

Looked at from this point of view, it is at once manifest how absurd it is to talk of acetylene as a possible rival of coal gas, and the sooner this is realized the better will it be for the future of this brilliant illuminant.

Abroad, where coal gas is dear, it is possible, by taking the price of acetylene in the holder and comparing it with distributed coal gas, to make acetylene out to be, light for light, as cheap as the latter when consumed in a flat flame burner; but even this method of calculation breaks down before the high light emissivity of the incandescent mantle.

It is in those districts where no coal gas exists that the true field for acetylene is to be found, and here its ease of generation and the beauty of its light makes it a pleasant companion after the greasy dimness of the candle or the smell of the oil lamp.

When I first attempted to burn acetylene I used the Bray nipples, which could be had on the market, and found that I obtained very high illuminating effects, and could, for a time, continue the combustion in a satisfactory way by using three or four inches pressure at the burner. This high pressure was, however, undesirable, and I then devised a cubic foot burner in which, by drilling the union jet holes of very small size and at a more obtuse angle, I was able to burn the gas at an inch pressure. About this period, also, Bray made specially small tips for use with acetylene, and both these nipples answered extremely well for a time and developed from 30 to 36 candles per cubic foot of gas, but they both had the same weakness, and after a few hundred hours began to smoke, and as a smoking acetylene flame covers everything in a room with a thick deposit of soot in a very short space of time, such burners were manifestly not fitted for the work they had to perform.

The trouble generally commenced with a filiform growth of carbon appearing at the nipple, which quickly distorted the flame and caused a cloud of soot flakes to descend. If the burner was cleaned and relighted, the trouble commenced again in an hour or two, and the only thing to be done was to replace the nipple by a new one.

If the nipple had been burning some time and was then removed and broken, it was found to be carbonized for some depth into the material, showing that a liquid hydrocarbon had soaked into the material and had been split up there by the heat with a deposition of carbon.

The generally accepted idea was that the heat of the nipple polymerized some acetylene to benzine, and this, forming a drop, did the mischief, and efforts to keep the burner cool were looked upon as a likely direction in which to search for success.

While these troubles were going on in England, attempts had been made in America to use acetylene diluted with a certain proportion of air, which permitted it to be burnt in ordinary flat flame nipples, but the danger of such admixture being recognized, nipples of the same class as those used in England were employed, and the same troubles ensued.

In France single jets made of glass were first employed, and then Risener Luchaire, Ragot, and others, made burners in which two jets of acetylene coming from two tubes, spaced some little distance apart, should impinge and splay each other out into a butterfly flame. Soon after Bullier introduced the idea of sucking air into the flame, at or just below the burner tip, and at this juncture the Naphey or Dolan burner was introduced in America, the principle employed being to use two small and widely separated jets instead of the two openings of the union jet burner, and to make each jet a minute bunsen in which each jet of acetylene dragged in from the base of the nipple enough air to surround and protect it while burning from contact with the steatite.

These burners were hailed with delight, and their success led to their being pirated right and left, but although these burners mark a very great improvement and will burn several hundred hours without smoking (unless in a fit of false economy the user insists on turning them down and leaving them for an hour or so as two small separate flames, in which case they generally start smoking on being again turned on), the trouble is by no means got over, and a Naphey burner will often be found smoking as heartily as one of its more humble brethren.

The fact is that the cause of smoking is to be found quite as much in the generator as in the nipple, and overheating during generation is undoubtedly a prime factor in this worrying phenomenon.

If smoke or tar vapor be examined under a high microscope power, it is seen that it consists of minute vesicles or bubbles in a most marvelously active condition of movement, and fulfilling in a most perfect manner the conception one forms of molecular motion. Ever bombarding each other, but never colliding, these small vesicles, filled with gaseous matter, continue their career until some mechanical action bursts them, and deposits the minute trace of liquid which formed the skin of the microscopic balloon.

It is for this reason that the most successful form of washer for extracting tar during the manufacture of gas consists of fine jets or orifices through which the gas passes at considerable velocity, afterward coming in contact with a baffle which breaks up the vesicles; and anyone with experience in carbureted water gas making knows the trouble that arises from filiform growths of carbon, when, owing to an insufficient temperature in the cracking and superheating chambers, the carbureted gas contains vapors, instead of permanent gaseous products.

When acetylene has been made in a generator at an undue temperature, it carries with it benzene vapor, which, as it commences to condense, assumes this vesicular form, and on coming to the extremely minute holes which form the apertures of the burner, the mechanical scrubbing which it encounters causes the

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breaking up of the vesicles and the deposition of the benzene and other hydrocarbons held in suspension by benzene, which soak into the steatite and carbonize. The presence of finely divided carbon has a great effect in determining the decomposition of the acetylene itself, so that a rapid growth of carbon takes place at the burner, and no ordinary clearing of the deposited carbon from the exterior will ever make the nipple fit for constant use again, as the catalytic action of the carbon deposited in the pores of the steatite, and which cannot be got rid of, causes the deposition of a fresh supply of carbon; while, when the benzene vapor gets past the nipple and burns, as it requires three times as much air as acetylene, it often starts the flame smoking from this cause.

The impurities, however, in acetylene other than vapors also play a certain part in the choking of the burner, as if there be much phosphureted hydrogen in the gas a small quantity of phosphoric acid is apt to be deposited in the burner nipple and helps to distort the aperture, while silica from siliciureted hydrogen has the same effect.

It will be found with experience that the prevention of smoking in a burner will be overcome quite as much by attention to the temperature in the generator as to the burner itself, and where a generator which gives overheating is in use, a well arranged scrubbing apparatus that would get rid of the benzene from the gas would be found a distinct advantage in stopping burner troubles, while, when proper purification is introduced, the burner troubles will be found to have been practically solved.

At the Acetylene Exhibition, held in Berlin early this year, all the newest forms of burner were shown; the best burners of each class were tested at the Imperial Physical Institute for consumption and light-giving power, and it was found after eighteen hours' burning that several had to be eliminated on account of their commencing to smoke. Thirty hours proved fatal to another batch, while a few only continued giving satisfactory results after that period—a result which shows that the same troubles which have been rife in England have been equally marked on the Continent.

The results also obtained as to the candle power of these burners fully bear out the figures which I have obtained. It may be of interest at this point to record the candle power of some of the many burners which I have personally tested, and these really represent the best results obtainable by the combustion of acetylene under domestic conditions.

Date.	Name of Burner.	Pressure.	Gas consumed	Light.	Candles.	
					per ft.	per 5 c ft
1894	Lewes.....	1·75	1·02	32·82	32·17	160·8
	Bray.....	2·0	1·85	64·0	34·59	172·9
1895	Acetylene 4-	1·5	0·5	12·0	24·0	120·0
1896	{ Naphey } { or Dolan }	2·0	0·6	16·0	26·6	133·0
1897	Falk Naphey	2·5	0·5	11	22	110·0
	" "	2·5	0·75	20	26	130·0
1898	" "	2·5	1·0	34	34	170·0
	Nurnberg ..	2·5	1·0	36	36	180·0
	Hera	2·5	0·8	26	32·5	162·5
	Ideal	2·5	0·75	20	26·5	132·5
	Bilwiller....	3·0	1·0	40	40	200·0

The Dolan or Naphey tip was a great advance at the time when it was introduced, but the arms which carried the tips were made of metal, and this was perpetuated in the first batch of piracies made. The effect of heat after a time is to slightly distort these arms, thus throwing the two jets of gas a little out of line. This trouble has now been got over by making the arms of the burner entirely in steatite, which, although adding to the cost, is a distinct advantage.

The incandescent mantle has made such a revolution in coal gas lighting that it is not surprising that attempts should have been made to adapt acetylene for this purpose, and the first thing which had to be done when taking steps in this direction was to construct an atmospheric burner which would satisfactorily consume the gas.

One would expect that acetylene, when consumed in an atmospheric burner, would give an excessively hot flame, not only on account of its composition, but also on account of its endothermic character. Le Chatelier calculates that the temperature of a non-luminous acetylene flame will range from 2,100° to 2,420° C., the temperature varying with the ratio of acetylene to air, as shown in the following calculations:

Percentage of		
Acetylene.	Air.	Temperature. Deg. C.
7·4	92·6	2,420
12·9	87·1	2,260
17·37	82·63	2,100

In order to make a Bunsen burner for acetylene, the tube has to be extremely narrow, and it is even then found to be very liable to flash back, while it needs a high pressure in order to bring about satisfactory combustion of the gas with an absolutely non-luminous flame. One of the chief difficulties which has to be overcome is due to the range over which mixtures of air and acetylene are explosive. This we have seen lies between the limits of 3 per cent. and 82 per cent. of acetylene, and it must also be remembered that the velocity of the explosion of acetylene when mixed with air is greater than with a mixture of air and coal gas, and the propagation of the explosive wave down the burner tube cannot be satisfactorily stopped by the ordinary device of using wire gauze, on account of the low igniting point of acetylene and air mixtures. If high pressures are used so that the rate of flow shall be greater than the velocity of propagation downward, more air is sucked in by the uprush of the gas and the velocity of the explosion is again increased.

The best results have been obtained by taking a bunsen burner in which a constriction in the air tube creates a high velocity at that point, which, on the principle of the Smithell's flame separator, prevents the propagation downward just at that point.

Le Chatelier has shown that the rate of propagation of an explosive mixture of air and acetylene depends upon the diameter of the tube through which the wave is being propagated, and he has worked out the limits between which the explosive wave would pass through tubes of certain diameters.

Diameter of Tube. Inches.	Explosion. Lower Limit. Per cent. Acetylene.	Upper Limit. Per cent. Acetylene.
1·57	2·9	64
1·18	3·1	62
0·79	3·5	55
0·24	4·0	40
0·16	4·5	25
0·08	5·0	15
0·03	7·7	10
0·02	0·0	0

It will be seen that in a tube 0·02 inch, or 5 mm. in diameter, you have the propagation of the explosive wave ceasing.

These investigations have been used as a basis upon which to construct acetylene burners for heating purposes, and burners have been made by the Allgemeine Carbid und Acetylen-gas Company, of Berlin, in which, by means of constricted tubes, satisfactory consumption is insured. It is found that the diameter of the tube at the constriction must be in a definite proportion to the particular mixture of air and acetylene consumed, as the more air employed the greater must be the constriction in the strangulated portion of the tube. Such burners have a flame which is very valuable for heating purposes and gives a very intense temperature.

The same company has also used these burners with incandescent mantles of somewhat different shape and composition to those ordinarily employed, and states that the photometric result is 30 to 40 per cent. higher than that obtained by the combustion of pure acetylene alone. I have lately been experimenting with an acetylene Bunsen and get much higher results than these. With a Welsbach No. 2 mantle I have obtained as much as 90 candles per cubic foot of acetylene consumed, and as far as I have gone the mantle appears to be hardened and strengthened by the intense heat to which it is subjected, but it yet remains to be seen how the life of the mantle is affected by the temperature of the flame.

Acetylene atmospheric burners are now also employed for heating, cooking, and metallurgical operations on a small scale, and with a reduction in the price of the gas these uses for it will undoubtedly open up a wide field of utility.

The value of acetylene in photographic work is now universally recognized, and Mr. W. H. Walmsley has determined its relative value as compared with the ordinary sources of light, by determining the time needed to fully expose carefully prepared plates, with the following results:

	Seconds.
Direct sunlight	1
Acetylene 1 cubic foot burner	3
Diffused daylight reflected from mirror	12
Incandescent mantle	24
Coal gas, Oil gas, Oil lamp	240

It is also to a certain extent used for projection work, but it is not so well suited for this, as, in common with multiple wick oil lamps and incandescent mantles, the flame offers too large a surface of illumination.

M. Molteni has attempted to determine the projection value of various illuminants by a photometric process in the following way:

The measurements were made with an ordinary lantern, the stage of which carried an opaque card in which was cut an aperture 0·7 cm. square, and the distance of the lantern from the screen was such that each side of the square on the screen measured 1 meter.

The screen was replaced by a disk of paper, the opposite side being illuminated by a standard lamp burning 42 grammes of oil per hour. The distance of this lamp was varied in order that equality of illumination might be obtained on the screen, and the photometric values of the light were determined from the distance of this lamp.

Multiplewick lamp	1·00
Incandescent gas No. 2 burner no reflector	1·00
Acetylene 1 burner no reflector	1·06
" 2 " "	1·70
" 3 " "	3·20
" 4 " "	4·10
" 5 " "	4·50
Limelight, alcohol and oxygen	5·80
" oxyhydrogen	16·60
" etho-oxygen	18·50
Electric incandescent 32 candle-power	0·68
Electric incandescent 50 candle-power vertical	0·93
Electric incandescent 50 candle-power horizontal	0·93
Electric focus 100 candle-power	3·82
" arc lamp 7 amperes	39·03
" " 10 "	75·61
" " 12 "	86·50
" " 15 "	117·61
" " 20 "	160·80

Carbide will probably some day become an important factor in the transmission of power, as a cubic foot of solid carbide would weigh 62·26 kilos or 137 lb., and if of commercial purity would yield 685 cubic feet of acetylene, having a thermal value of nearly 232,215 calories.

In practice, however, the weight of carbide which can be got into a cubic foot space is dependent on the size to which the material is broken, and with the ordinary commercial carbide a fair average would be 80 pounds per cubic foot, yielding 400 cubic feet of acetylene gas, with a thermal value of 139,600 calories. It is at once manifest that solid carbide is as economical a method of transporting acetylene as if liquid acetylene itself were employed, as the liquid will only yield about 400 times its own volume of gas, and the carbide has the advantage of being practically safe in transit.

There are several people at present working on the utilization of acetylene for gas motors, but there are many difficulties to be overcome before this is successfully accomplished, as the deposition of carbon when the air supply is insufficient and the violence of the explosion are troublesome factors to deal with.

The trouble of completely consuming acetylene without smoking in the early days of its inception caused Dickerson and Suckert to attempt the combustion of acetylene diluted with air. In 1894 it was in this way that the gas was consumed, but not only did the cooling action of the nitrogen lead to a considerable decrease in illuminating power of the acetylene so diluted, but, as will have been seen from the experiments of Gerdes and others, a very serious risk was incurred, it becoming merely a question of the breadth of the delivery tubes and the rate of flow of the gas whether an explosive wave was propagated back to the mixing machine or not. It was on account of the danger of this that this process of burning it in America was abandoned.

The idea has, however, cropped up from time to time since, and both in France and Holland has been, to a certain extent, used on a practical scale. Even at the present time an attempt is being made in Manchester to introduce a process by which acetylene can be so diluted with air as to burn in an ordinary Bray burner.

The danger of diluting acetylene with air being so manifest, attempts have, from time to time, been made to dilute it with other gaseous material. In 1895 Bullier took out a patent for improvements in carburetting air and gas, in which he claims the use of acetylene for enriching water gas; while having then apparently found that acetylene was useless for this purpose, he, later on in the same year, took out a second patent for diluting it with nitrogen. It was about this time, also, that Mr. Gerdes commenced his experiments upon the enrichment of oil gas with acetylene, which have borne such ample fruit on the Continent. He showed that when oil gas is enriched with 25 per cent. of acetylene a valuable increase in its illuminating power is obtained without any danger of explosion of the mixture owing to heat or shock. This mixture is now employed to a very large extent on the Prussian railways; the quantity of carbide already used this year for this purpose has reached a total of 3,000 tons, and it is computed that before the end of next year 10,000 tons per annum will be needed for this purpose.

In consequence of the great Continental success of this admixture, application was lodged at the Home Office to sanction such a mixture in England under the ordinary railway carriage cylinder pressure of ten atmospheres. The safety of the mixture and of mixtures considerably richer in acetylene was completely established by a series of tests carried out in the presence of the Home Office officials, and in consequence, by an order of the Secretary of State, dated March 28, 1898, a mixture of oil gas with 20 per cent. of acetylene is allowed to be used at a pressure not exceeding 150 pounds on the square inch.

In order to determine the increase in illuminating power given by various percentages of acetylene in oil gas, and whether the mixture could be employed with economy, the following experiments were instituted. Oil gas containing 20 per cent. of acetylene was compressed into a cylinder under a pressure of ten atmospheres, some of the original oil gas being also compressed in a second cylinder to the same pressure. Both cylinders were then blown off to 5·8 atmospheres, and the illuminating power of each was taken under identical conditions. The burner used was a "40 liter" one, and the results were as follows:

Pressure.	Gas Consumption.	Illuminating Value. Oil Gas.	Oil Gas and Acetylene.
5·8	1 cubic foot	7·4	15·6

An analysis of the gas showed that the mixture contained 22 per cent. of acetylene, although but 20 per cent. was originally added, the increase being due to the loss of some of the oil gas in which under pressure some of the vapors of benzene and toluene condense to the liquid state. Working from these figures it will be seen that the addition of 22 per cent. of acetylene caused an increase of illuminating power of 110 per cent., or 100 per cent. with 20 per cent. of acetylene.

The original oil gas and the mixture of oil gas with acetylene were next determined photometrically in an ordinary railway carriage lamp at angles below the horizontal on the Diodin radial photometer.

OIL GAS.

Angle.	Pressure.	Gas.	Candles.	Candles, per foot.
Horizontal	1·0	2·0	7·4	3·7
10	..	..	8·0	4·0
20	..	..	8·2	4·0
30	..	..	8·2	4·1
40	..	..	8·2	4·1
50	..	..	8·0	4·0
60	..	..	7·6	3·8
70	..	..	7·8	3·9
80	..	..	8·0	4·0

Average candles per cubic foot..... 3·9

OIL GAS AND ACETYLENE.

Angle.	Pressure.	Gas.	Candles.	Candles per foot.
Horizontal.	1·0	2·0	17·0	8·5
10	..	..	17·0	8·5
20	..	..	17·5	8·75
30	..	..	18·0	9·0
40	..	..	17·0	8·5
50	..	..	17·0	8·5
60	..	..	17·0	8·5
70	..	..	16·5	8·25
80	..	..	16·5	8·25

Average candles per cubic feet 8·5.

This shows that the addition of 20 per cent. of acetylene increases the illuminating power of the oil gas by over 110 per cent. at all angles.

These figures show therefore that the addition of the 20 per cent. of acetylene doubles the illuminating value of the oil gas.

With regard to cost, as we have before seen, acetylene at the present price of carbide will cost about £1 18s. to £2 per 1,000 in the holder, and 200 cubic feet will accordingly cost 7s. 8d. The compressed oil gas costs from 6s. to 12s. per 1,000. With oil gas at 8s. per 1,000, 800 cubic feet will cost 6s. 5d., so that the total cost of 1,000 cubic feet of the enriched gas will be 14s. 1d., but as the illuminating value of the mixture is double that of the plain oil gas, there is an economy of 1s. 11d. per 1,000. As the oil gas is dearer, the saving will be greater, and vice versa, so that with cheap oil gas the addition of acetylene would not pay. With oil gas at 6s. 6d. per 1,000 there is practically no difference, but the advantages accruing from the use of acetylene would make the mixture more desirable than the plain gas. Among the advantages are these—that the cylinders would last for double the length of time they would with the oil gas having the one charge, and there would be not so much formation of liquid hydrocarbons due to compression, with consequent revaporizing when the pressure is reduced, thus causing inequality in the illuminating power.

The whole question of diluting acetylene with other gases has had a very great interest for me, and I have made many experiments in order to determine how it is that when 10 per cent. of acetylene is added to a diluent such as blue water gas, carbon monoxide, or even hydrogen, the resulting mixture is practically non-luminous, and I have worked out the enrichment value for acetylene for all those gases which might be employed for its dilution.

I soon discovered from these experiments that methane is the only diluent which sustains the illuminating power of the acetylene when mixed with it in small proportions, and the fact that the same phenomenon is observable in comparing the illuminating power of mixtures of gases containing only some 30 per cent. of methane gives at once a clew to the methods which must be adopted in making a diluting gas for acetylene.

It is perfectly obvious that in many places it would be a great advantage to have an illuminating gas of about 20 candle power for general distribution in the same way as a good coal gas could be used, if such a mixture could be produced at a price comparing favorably with coal gas under the same conditions. In order to do this, although it would be impossible to use pure methane as the diluent for acetylene on account of the cost of its production, it is quite easy to make diluting gas which shall contain 30 per cent. of methane at a comparatively low rate.

In order to make this, a slightly modified form of water gas generator is employed, and the fuel having been blown up to incandescence by an air blast, tar, creosote oil, heavy oil residues, or practically any waste liquid, hydrocarbon is injected into the body of incandescent fuel by a steam injector or atomizer. If these hydrocarbons were allowed to run into the fuel by themselves, they would simply be burnt up to carbon and hydrogen, but steam being injected with them, the steam is decomposed by the fuel with the formation of water gas, which to a certain extent envelops the hydrocarbon, and instead of its undergoing a complete decomposition, it is broken down to methane and hydrogen and mingles with the water gas, while any residual carbon is left behind in the fuel. It is quite possible by such means to make a diluting gas containing:

Hydrogen	45
Carbon monoxide	15
Methane	30
Unsaturated hydrocarbons	5
Carbon dioxide and nitrogen	5
	100

This gas costs from 8d. to 10d. per 1,000 cubic feet, and has an initial illuminating value of about 10 to 12 candles, and on mixing with it 5 per cent. of acetylene, a gas having an illuminative value of 18 to 20 candles is obtained, which, being a mixture of perfect gases, gives no trouble as regards layering, and which, having the same specific gravity and illuminating value as coal gas, can be distributed and burnt in precisely the same way.

It is also found that mixtures of this gas with 50 per cent. of acetylene are not detonated when compressed for railway carriage lighting by any temperature which it would be possible to attain in the cylinder, and it seems that this method of utilizing acetylene is pre-eminently the one which promises for it the largest and most remunerative future.

In concluding this course of lectures, I am oppressed by the feeling that the limited time at my disposal has prevented me from doing full justice to my subject; and I should have far preferred a course of forty rather than four lectures in order to deal with the many important points and side issues which of necessity have been omitted. I leave my subject with the sincere hope that, as time wears on, those points which appear to us now to be difficulties will be made clear, and that in the future cheapened carbide will enable this beautiful hydrocarbon to take its proper place in the foremost ranks of our illuminants.

APPARATUS FOR NICKEL PLATING NUMEROUS SMALL OBJECTS AT A TIME.

PLATING with nickel is now extended to numerous pieces of machinery, of which it prevents the oxidation and to which it gives a brilliant and durable polish. This operation, along with the bicycle and automobile industry, has assumed so great a development that it has become necessary to have recourse to rapid methods for treating a large number of small objects at once. Not only is an endeavor made to reduce the duration and cost of the work, but also to avoid certain imperfections inherent to the treatment of the objects in a lump, and consequently the expense of hand labor necessary for doing the work over again and rectifying defects.

Whatever be the modus operandi, the objects to be nickel plated must first be prepared with the greatest care, since upon the attention paid to the preliminary treatment depends to a great degree the final success.

No one is now ignorant of the fact that a coating of nickel does not give a perfectly smooth surface unless the objects have been carefully polished before being put into the bath. From the necessity of giving the pieces beforehand the aspect that they are to receive through nickel plating, it results that well organized shops are obliged to use special methods and tools in order to render the polish as perfect as possible. It is likewise necessary that the pieces shall be carefully freed from every trace of grease. To this effect, they are placed in a bath of boiling potash, and then, after a rinsing in water, they are cleaned in a bath composed of one part nitric acid and ten parts of water. After a second rinsing the pieces are ready to be plated.

We now come to the arrangements employed for the immersion in the bath. In many shops, the objects (bicycle spokes, for example) are inserted in apertures formed in plates of tin and placed vertically in the electrolytic bath. A holder of this kind receives from 80 to 100 spokes, which are arranged in three or more rows—an operation that consumes considerable time. Besides, the spokes that are nearest the anodes become more thickly plated than those that are more distant, and in the part in contact with the tin support all are covered with merely a thin layer of nickel. Finally, there is another inconvenience, which is due to the fact that the lower part of the spokes undergoes a change before the upper is sufficiently plated, and consequently it becomes necessary to destroy the tarnish that has formed upon the first by a vigorous polishing.

An endeavor has been made to surmount this difficulty by placing the spokes horizontally upon the supports. But this requires still more time than the preceding arrangement and produces two surfaces of contact upon which the spokes become but slightly plated with nickel, and the result is that, in order to render the coating uniform, it becomes necessary to turn the spokes over upon their supports and to replace them in the bath. Yet, however skillful be the workman, he will allow a few to fall, and these it will be necessary to clean anew. The two processes that we have just mentioned have the further drawback that they require vats of large dimensions.

A third process, which also is much employed, consists in placing a large number of spokes upon wire gauze suspended in the bath and in moving them about from time to time. But, practically, this gives rather unsatisfactory results as regards the thickness and adhesion of the deposit. Now the spokes of a bicycle are more exposed to rust than any other part of the machine, and for this reason they have to be treated in strong baths that quickly give a thick coating of nickel. After this is obtained, it requires a careful and, consequently, costly polishing.

As regards the reduction of the manual labor employed in putting the spokes in place and afterward polishing them, a notable improvement has been made in a device that forms the subject of several patents, one of which, among others, has recently begun to be exploited in France by Messrs. Gruaer & Company.

In Fig. 3 may be seen the arrangement of the apparatus devised for carrying on this process. A drum of hexagonal form has in one of its sides a door through which are introduced the objects to be plated, and revolves upon journals under the action of a belt, *B*, driven by a three-speed gearing.

The supports of the journals of this drum are, like the belt pulley, suspended from a cross piece, *C*, held in position over the vat during the work, but capable of being raised by means of cables, *DD*, passing over guide pulleys. It is thus easy to charge the drum and remove the nickel plated pieces from it.

The bath should be alkaline and the density of the nickel solution should reach from 8° to 9° Baumé at a temperature of no less than 15° or 16°. The necessary

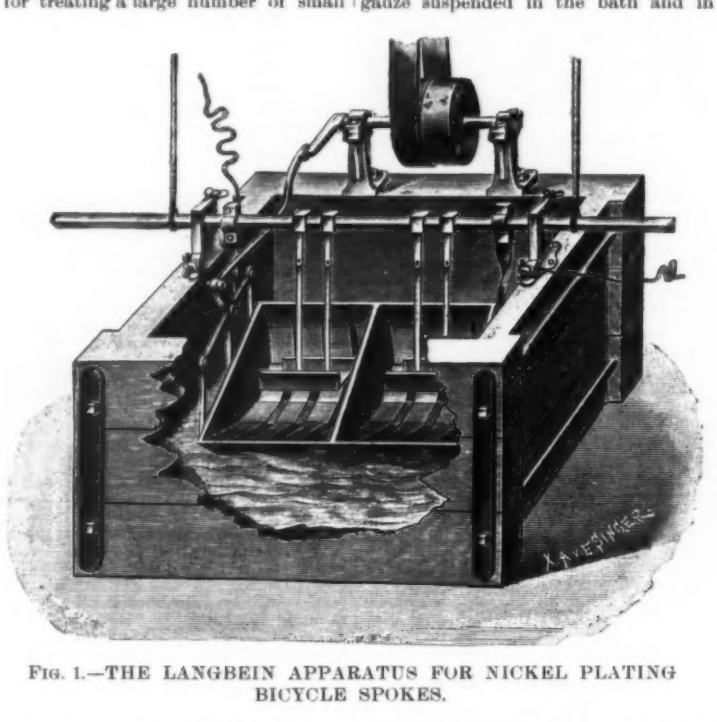


FIG. 1.—THE LANGBEIN APPARATUS FOR NICKEL PLATING BICYCLE SPOKES.

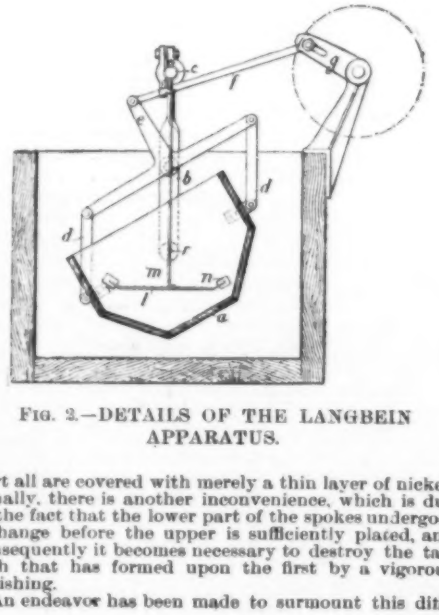


FIG. 2.—DETAILS OF THE LANGBEIN APPARATUS.

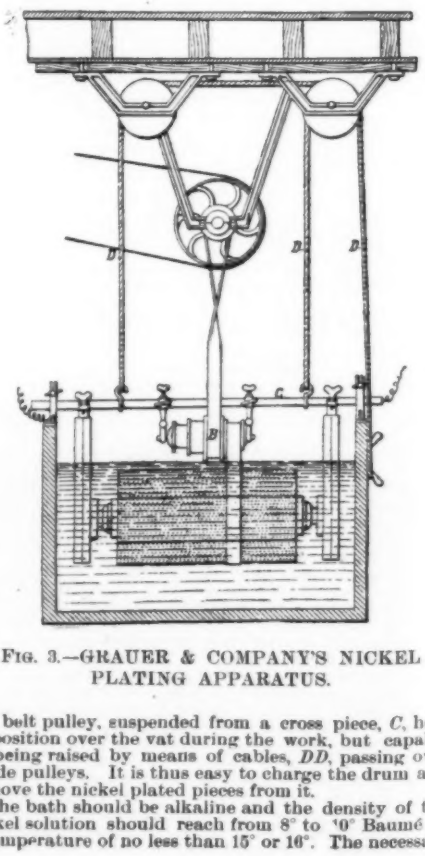


FIG. 3.—GRAUER & COMPANY'S NICKEL PLATING APPARATUS.

number of amperes is distributed at a tension of from 6 to 8 volts.

When round objects are treated, the drum may be run at a velocity of 55 revolutions per minute. The objects become polished therein by friction against each other, and acquire a brilliant white color. The drum, however, should be but half full.

If it is a question of flat pieces, the drum is run at a speed of but from 3 to 5 revolutions per minute. A subsequent polishing is then necessary, as is likewise the case when the drum is filled full of round objects, since, when the latter are taken out of the bath, their coating is dead.

In this manner it is possible to treat from 500 to 1,000 pieces at once and to increase the rendering to a very great extent, while at the same time reducing the manual labor.

An apparatus which is no less interesting has recently been devised by Dr. Langbein, of Leipzig, to whom, after numerous experiments, the idea has occurred to employ an open receptacle having simply an oscillating motion. According to the inventor, everything that tends to interfere with the uniformity of the coating and necessitates expensive rectifications is in this way absolutely avoided.

Figs. 1 and 2 show that the receptacle, *a* (which is of wood and placed in the vat), is jointed to the arms, *b*, which are suspended from the bar, *c*, from which they are electrically insulated by sleeves of hardened rubber. This receptacle receives an oscillatory motion from the rods, *d*, of the triangular lever, *e* (which likewise is jointed to the arms, *b*), from the rod, *f*, and finally from the crank, *g*, the length of which is regulatable.

To the internal surface of the receptacle there are screwed transverse and longitudinal strips of copper that close the circuit of the source of electricity upon one of the journals, *r*, of the bar, *c*, which carries the conductor connected with the negative pole.

The anodes, *ll*, are suspended by metallic rods, *m*, from the bar, *c*, which is connected with the positive pole. They enter the receptacle, *a*, and consist of bent plates of which the edges are provided with pieces of wood, *n*, to prevent short circuits with the anode.

The rocking motion communicated to the objects to be nickel plated is not violent enough to produce an entanglement of them or to cause any damage to them whatever; and, by reason of the proximity of the anode and cathode and the resulting feeble electric resistance, such motion contributes efficiently toward obtaining in a short time a uniform and thick deposit upon the objects. The latter, in rolling upon one another, mutually polish each other and strengthen their coating, which, it appears, is always free from fissures and scales.

In this way it is possible to nickel plate bolts, screws, nuts, chains, etc., and employ them on coming from the bath, after a washing in cold water and a drying in sawdust. A slight, and consequently inexpensive, polishing rapidly gives them a beautiful luster.

For the above particulars and the illustrations we are indebted to the Revue Industrielle.

A NEW ACETYLENE LAMP.

ACETYLENE lamps are now very numerous, especially portable ones, and inventors are continually presenting new styles. Up to the present, there perhaps exists no lamp that really gives satisfaction and that is capable of lending itself in practice to continuous use.

Prof. E. Gossart, of the Faculty of Sciences of Bordeaux, has devoted himself since 1896 to a study of acetylene and to the work of finding an apparatus to permit of the use of it, and, in 1897, presented to the Société d'Encouragement a special model of a gas generator and a lamp.

The lamp consists, in principle, of two very distinct parts placed one above the other. One of these, *B*, at the lower part receives the calcium carbide, while the other, at the upper part, contains the water. The water reaches the carbide through capillary tubes, of which the operation seems to establish a self-regulation.

The calcium carbide, *g*, is placed in a basket of wire gauze and within a thin cylinder of brass, *d*. The whole is inclosed in a jacket, *e*. Care is taken to leave a circulation of air between the two cylinders in order to quicken the cooling.

Above the two cylinders there is a cover, *C*, of moulded brass, held upon the sides through jointed bolts, *D D*. This cover is provided with a groove, *h*, in which there is a ring of rubber upon which the cylinder, *d*, rests.

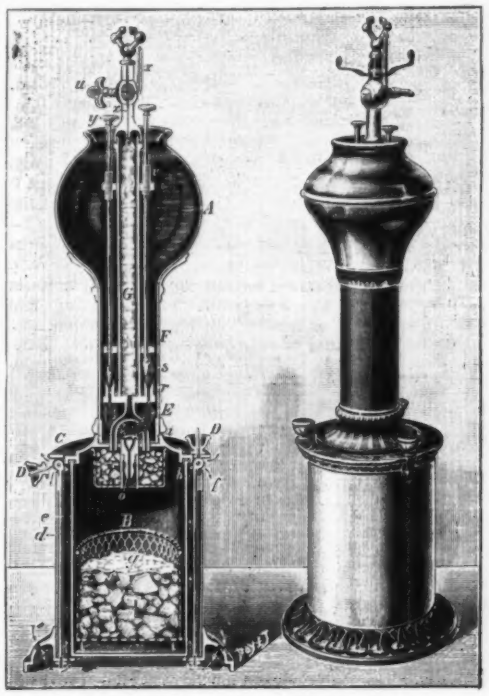
To the center of the cover there is screwed, and held by a leather joint, a strong brass tube, *F*, which is connected with a spherical reservoir, *A*. At the extremity of this tube, in the lower cylinder, there is at the center, *o*, a small ajutage surrounded by a basket that likewise contains carbide. This ajutage ends, as may be seen, in two small conduits, each of which is connected with a capillary tube, *E*. It is through these tubes that the water flows, drop by drop, upon the carbide. Above the second carbide basket, of which we have just spoken, are placed two other tubes which unite and debouche in a tube, *G*, filled with wadding. The acetylene gas, upon disengaging itself, traverses the carbide, which dries it, and then the tube, *G*, in which it gives up its impurities to the wadding, and reaches the capillary escapement tube, *x*, which is half a millimeter in diameter and 40 millimeters in length. Finally, it traverses the cock, *u*, and reaches the two inclined burners.

The two capillary tubes, *E*, are of metal that acetylene does not attack, and are of a length varying between 30 and 100 centimeters. At their upper part they engage with the bottom, *r*, of small conical sheaths. It is through these orifices that the water of the receptacle, *A*, flows in order to traverse the capillary tubes. At *s*, at the extremity of rods, are fixed valves that enter the apertures and are capable of closing them. The rods that permit of maneuvering these valves are provided with screws at *v* and are capable of being manipulated from the exterior by means of buttons, *y*.

The cock, *u*, is a three-way one. In its open position, the gas is directed into the two burners. When it is closed, after the arrest of the water, the superproduction burns totally in a small lateral burner that serves as a lighter.

To set the apparatus in operation is a very easy matter. The receptacle, *A*, is first filled with water, and the operation of the capillary tubes is verified in drawing out the upper part of the lamp. The vertical rods are maneuvered by means of the buttons, *y*. One of the apertures allows from fifteen to twenty drops of water to fall per minute. The baskets are now filled with carbide. The tube is replaced upon the lower cylinder, and the bolts, *D D*, are screwed home. Then the valves are opened and the burners are lighted. The flame is at first pale and somewhat hissing, but soon assumes great brilliancy. Then the valves are closed.

One of the models now manufactured weighs 2 kilogrammes, contains about 500 grammes of carbide and as much water, and furnishes 150 liters of acetylene. This gas, in a burner discharging 20 liters an hour,



GOSSART'S ACETYLENE LAMP.

gives a luminous intensity of 25 candles for seven or eight hours.

In this new lamp all the details have been studied by Prof. Gossart with the greatest care. Its operation is interesting to examine. The self-regulator of the flame consists of the capillary tubes that regulate the flow of the water, and of the tube, *x*, of the burner, which offers a resistance to the flow of the gas. When the production of the gas is greater than the consumption the drops of water do not fall so quickly, and when the consumption of the burner increases, the drops fall more rapidly.

For the above particulars and the illustrations we are indebted to La Nature.

HEATING BY COAL TAR.

THE idea of heating by coal tar, due to Mr. Edmund Shurer, emanates from the very logical desire to effect a saving in industrial operations by supplying furnaces with a fuel that burns therein more perfectly. We have here a question of prime importance, not only from the standpoint of economy, but also from that of smoke consumption. In order to obtain such simplification and saving, certain inventors are endeavoring to render practical the use of pulverized fuel, while others (and these are in the majority) favor the use of a liquid fuel, thanks to which the simple maneuvering of a cock would assure the feeding of the fire, just as a gas range is supplied in modern kitchens. However, the only fuel of which there has been a question up to the present has been petroleum or its residue from distillation, "astatki." Coal tar is entirely a novelty in the question. Let us recall the fact that this is a by-product in the manufacture of illuminating gas, and also that it is sometimes collected in the carbonization of coal in furnaces with a view to the production of metallurgic coke. Most diverse products are already derived from it, for although it is used in a crude state for the preservation of building materials and the manufacture of roofing, printing ink, etc., it yields by distillation many and very valuable substances, such as naphtha, naphthaline, creosote, benzole, aniline colors, etc. But coal tar is produced by hundreds of millions of tons, and it will be found easy to procure it as a fuel whenever we shall possess a simple system that will permit of burning it in industrial furnaces.

Mr. Shurer, whom we mentioned above, and who is the general manager of the great maritime works of the Fairfield Shipbuilding Company, at Govan, near Glasgow, has succeeded in giving a practical form to the burners that he has devised and that have already been submitted to very conclusive tests. An examination of the accompanying figure, from La Nature, will allow the arrangement adopted to be easily understood.

If we examine the face of the boiler here represented, we shall see to the left a tar reservoir of rectangular form (although the form is of little consequence), and which at Govan holds 1,600 gallons. As the tar must be kept therein in a sufficiently liquid state to be sent to the burners by a pump, a spiral steam tube is arranged in the reservoir. This tube, which is about half an inch in diameter, ascends and runs along the wall and ceiling and forms a spiral in the midst of tar contained in another and smaller reservoir into which the liquid fuel is pumped, and thence flows to feed the burners.

At the extremity of the reservoir there is an aperture for filling, an aerating tube, and a tube that permits of the suction of the tar by the pump.

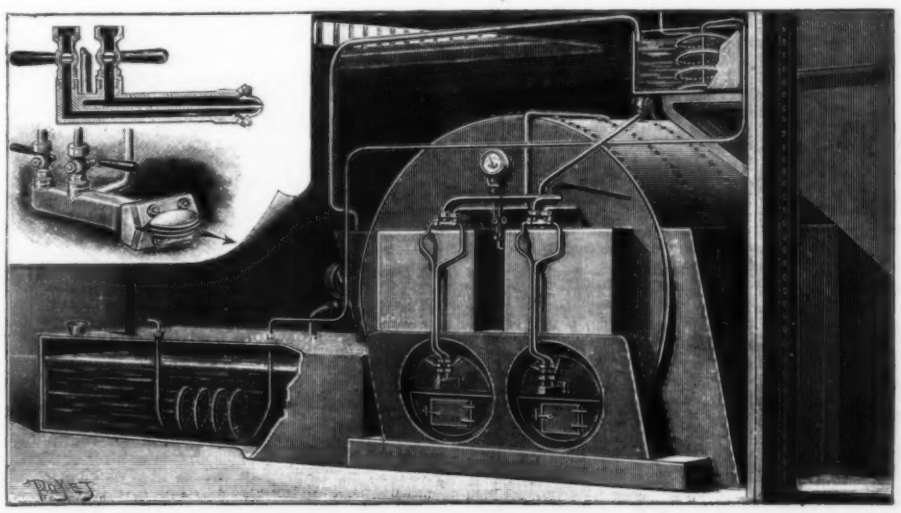
From the upper reservoir the coal tar descends through a conduit that leads it to a tube in the form of an inverted U. The steam arrives in the same manner, and each extremity of the U delivers either steam or tar to a cylinder, whence both flow through vertical tubes three-quarters of an inch in diameter to each burner. We need not explain how the burner is fixed in the furnace door, but only how it is arranged internally. The two vertical tubes, mentioned above, end in the common mounting represented in the figure to the left. Each is continued through a conduit at right angles, from which it can, of course, be isolated through a cock. Finally, the burner terminates in a nozzle containing two apertures one above the other—the upper one for the fuel and the lower one for the steam, the latter drawing the former into the furnace, where ignition and combustion take place as in apparatus for heating with petroleum.

In the mounting of the burner there is a cock, of which the opening debouches in the bottom of the nozzle reserved for the tar. This, after the apparatus has been arrested for a certain length of time, permits of sending into the nozzle a current of steam that thoroughly cleanses it and removes the cold tar.

The sole difficulty with this ingenious system consists in the fact that, in order to ignite the fuel and set things in operation, one must have at his disposal a certain quantity of steam to form a jet at the beginning. But in a large installation nothing would be simpler than to establish a small auxiliary boiler designed solely for furnishing the steam for setting the system in operation.

We have stated that Mr. Shurer's invention has been submitted to practical trial. As a matter of fact, the arrangement that we have described has already been applied for a certain length of time to one of the boilers that supply the hydraulic machinery of the Fairfield works, and it has been found that a considerable saving is effected by the substitution of tar for coal. With the latter the expense per week, inclusive of the wages of the stokers, was $40, while with tar it dropped to $24. For an operation of 116½ hours 15 tons of coal were burned, and for the same work 9 tons of tar residue sufficed. At Govan coal sells at $2.40 a ton, while the other material can be had for about a cent a gallon.

The Commission which has been appointed to report on the condition of the Philippine Islands contains two men of scientific attainments, Prof. Schurman, of Cornell University, and Prof. Dean C. Worcester, Associate Professor of Zoology of the University of Michigan. The latter gentleman has written a very important book on the Philippine Islands which has been well received.



VIEW OF APPARATUS AND ARRANGEMENT OF BURNERS FOR HEATING BY COAL TAR.

THE ECONOMIC STATUS OF INSECTS AS A CLASS.*

The popular conception of insects in general is undoubtedly that they are injurious. Many writers, it is true, have pointed out the benefits derived from insects, but we think of their damage to crops and of their annoyance to man and animals, and this aspect of the subject is at once apt to preponderate in our minds. It is more than 80 years since Kirby and Spence contrasted the injuries caused by insects with the benefits derived from them, and it has not been comprehensively done since. In the meantime, whole groups of important injuries have been developed and whole classes of beneficial work have been discovered. Moreover, the tendency of modern thought has not taken this direction. The biologic, taxonomic and phylogenetic, and other aspects of large groups of forms of life have been considered to the exclusion of the economic aspect, and even where this side has attracted attention, investigators have confined themselves to specific problems and have not generalized. It may be interesting, therefore, once more to contrast the injurious insects with the beneficial ones in an effort to gain a clearer idea of the status of the group in its relations with man.

In a broad way we may consider the subject under the following heads:

Insects are injurious:

1. As destroyers of crops and other valuable plant life.
2. As destroyers of stored foods, dwellings, clothes, books, etc.
3. As injuring live stock and other useful animals.
4. As annoying man.
5. As carriers of disease.

Insects are beneficial:

1. As destroyers of injurious insects.
2. As destroyers of noxious plants.
3. As pollenizers of plants.
4. As scavengers.
5. As makers of soil.
6. As food (both for man and for poultry, song birds and food fishes) and as clothing, and as used in the arts.

DESTROYERS OF CROPS AND OTHER USEFUL PLANTS.

In the present balance of nature one of the chief functions of insect life is to keep down superabundant vegetation. Almost every kind of plant has its insect enemies, and has had such enemies for many thousands of years. So soon as man began to make an effort to upset nature's balance by cultivating certain plants at the expense of others, he encountered nature's opposition by means of the increase of insect enemies of the particular plant cultivated, and almost as early as there is any record of agriculture in literature there is also mention of the destruction to crops caused by insects. Witness the writings of the prophet Joel, who might almost be termed an agricultural pessimist.

At the present time almost every cultivated crop has not only its thousands upon thousands of individual insect enemies, but it is affected by scores and even hundreds of species. A mere tabulation of the insect enemies of the apple already recognized in this country shows 281 species, of clover 82 species, and of so new a crop as the sugar beet 70 species. The insects of the vine, of the orange, of the wheat crop, and, in fact, of all of our prominent staples, show equally startling figures.

The actual damage which is done by insects in this way is difficult to express. Many attempts have been made by writers on economic entomology to express it in money values. For example, it was estimated by the late Professor Riley that the average annual damage to cultivated crops by injurious insects in the United States amounted to three hundred millions of dollars. The loss from the ravages of one species alone, the chinch bug, during one year was estimated at sixty millions of dollars. While it is true that the combined losses of individual growers might reach such enormous sums as these, there is an element in the total loss which we must not fail to take into consideration, and that is the enhanced value of the portion of the crop which remains. Even in the case of an individual a man may lose, for example, half of his crop through the work of the chinch bug, and yet, through widespread damage by this insect, the money value of the portion harvested may reach an amount almost as great as would have been gained through the low prices of a successful year of no insect damage. As this applies to an individual, it applies much more strongly to a State or to the country at large, so that even in the year when the grain crop of the country was said to have been damaged to the extent of sixty millions of dollars it is safe to say that the total price gained for the crop was as great as it would otherwise have been. These estimates of damage, therefore, would much better be expressed in terms of bushels, or some other measure, than in money value.

It is this aspect of our subject, the damage done by injurious insects to agriculture, that has given rise to the comparatively new branch of applied science which we now know as economic entomology, and which, although originating in Europe, has been encouraged to such an extent in our own country, owing partly to our greater necessities and partly to our practical turn of mind, that it is safe to say that at present America leads the rest of the world in this direction.

It is undoubtedly true that this enormous injury to crops is the chief item in a general consideration of the injuries brought about by insects.

AS DESTROYERS OF STORED FOODS, DWELLINGS, CLOTHES, BOOKS, ETC.

It is safe to say that there is hardly any product of man's ingenuity, hardly one of the thousands of useful materials upon which depend his comfort and happiness, which is not damaged, directly or indirectly, by insects. The timbers of which his dwellings are built, nearly all of his household utensils, his garments, practically everything which he uses as food, many of the liquids used as drink, his books, the ornaments with which he surrounds himself, the medicines which he takes when sick, the very tobacco with which he solaces himself—all are destroyed or injuriously affected by insects. There is, perhaps, one group of exceptions, and that is those articles which are composed wholly of metal, and yet even here insects may occasionally play an injurious part, since instances are on record of the destruction of lead pipes by insect larvæ, and the perforation of the metal linings of water tanks by small beetles.

Such injuries to human products are more frequent and serious in tropical regions than in temperate zones, but even here insects of this nature cause very serious inconvenience and great annual loss. It will answer our purpose, perhaps, to list some of the varying substances which are damaged in this way, to get an idea of their almost universal character: Ham, cheese, salted fish, butter, lard, dried mushrooms, rye bread, sweetmeats and preserves, powdered coffee, almonds and other nuts, raisins, breakfast foods, chocolate, ginger, rhubarb, black pepper, vinegar, sugar, wines, canned soups, tobacco, snuff, licorice, peppermint, aromatic cardamon, anise seed, aconite, belladonna, musk, opium, ginseng, chamomile, boneset, hides, shoes, gloves and other leather articles, furniture, carpets, drawings and paintings, paint brushes, gun wads, combs, etc., made of horn; hay, oats, straw, willow baskets, ax handles, ladders, wheel spokes, and all sorts of agricultural implements with wooden handles, barrels, wine casks, corks of wine bottles, sheets of cork, natural history collections, including skeletons and mummies, and even Persian insect powder! The mention of this well-known insecticide reminds one of the latest discovery, which is that certain flies in California breed in the crude petroleum pools in the vicinity of oil wells, a fact which is almost paradoxical in view of the extensive use of petroleum as an insecticide.

AS INJURIOUS TO LIVE STOCK AND OTHER USEFUL ANIMALS.

Every species of animal which has become domesticated and is of value to man possesses its insect parasites and enemies. These in many cases are the same species which affect man and which we will mention in the next section; others are specific to the animals or groups of animals which they affect. Horses, cattle, sheep, all possess insect enemies which are not only very deleterious to their health, but frequently cause their death in numbers.

The disgusting bot fly of the horse, whose maggots live in incredible numbers in the stomach and intestines of this noble friend of the human race; the bot fly of the ox, which causes innumerable sores on the backs of cattle and by its perforations ruins their hides for commercial use; the bot fly of the sheep, which inhabits the nasal and orbital sinuses of the sheep and produces insanity and death—will instantly be recalled by those who are familiar with stock raising; while hundreds of other species, some in no less degree, as the horn fly, the numerous gad flies, including the Tsetse fly of Africa, the screw-worm fly of our Southwestern country, unite to make the lives of domestic animals a burden to themselves and a trial and a loss to their owners.

An interesting attempt was made some years ago by a prominent Western agricultural newspaper, The Farmers' Review, to estimate approximately the pecuniary loss from the attacks of a single one of these insects—the ox bot fly, or ox warble—on the cattle received at the Union Stock Yards of Chicago. It was estimated that 50 per cent. of the cattle received each year are affected. The number of cattle received at the yards during six months of the year 1889 was 1,335,026; the average value of the hide was $3.90; the usual deduction for hides damaged by the ox warble was one-third. Estimating at less than one-third, say $1, the actual loss during six months on hides alone was $667,513. When to this was added the loss for depreciation in value and lessened quantity of beef, the loss for each infested animal was put at $5, a very low estimate, indicating the total loss from the animals in the Union Stock Yards of Chicago for a period of six months of $3,336,565.

AS ANNOYING MAN.

There are very few regions of the habitable globe where man is not personally subject to more or less annoyance by insects. In this part of the world we naturally think at once of mosquitoes, house flies, fleas, and of a certain other species which it will not be necessary to name.

A susceptible individual some years ago wrote to the Department of Agriculture and said that he had come over from the old country and settled in New Jersey, but that the mosquitoes bothered him so greatly that on the advice of friends he moved to northern New York. Here he found that during a certain portion of the year black flies made life unendurable; thereupon he packed his household effects and moved to North Carolina. Here, however, in the summer months red bugs, or jiggers, bothered him to such an extent that he feared he would go crazy, and in this desperate condition he applied to this office to learn whether there existed in the United States a locality where a sensitive individual could find peace from attacks of insects. He said that he had been told that in the Western country the buffalo gnat was greatly to be feared, while certain other biting flies would be sure to keep him in a constant state of dermal irritation; that further south he knew that peaceful nights were to be gained in the summer time only under the protection of mosquito bars. He had thought of the newly developing country of Alaska, but had recently seen an account in the newspapers of the ferocity of the Alaskan mosquitoes, which had practically destroyed his last hope.

Accustomed as most of us are to the mosquitoes of temperate North America, we hardly realize the impression which they made upon the early English travelers. A story told by Kirby and Spence, to the effect that Mr. Weld in his travels relates from General Washington that in one place the mosquitoes were so powerful as to pierce through his boots, has always excited my interest and curiosity, and I recently took the trouble to consult the original publication, which is "Isaac Weld's Travels Through North America, 1795–1797," London, 1799. In speaking of Skenesborough, in northern New York, Mr. Weld dilates upon the number and ferocity of the mosquitoes, and makes use of the following words: "General Washington told me that he never was so much annoyed by mosquitoes in any part of America as in Skenesborough, for that they used to bite through the thickest boot." Now, knowing that the boots of those days were very thick and that the mosquitoes of that time must have been structurally identical with those of to-day, there arises instantly a question of veracity between Mr. Weld and General Washington; and as we know from Dr. Weems' veracious history that General Washington was so constituted that he could not tell a lie, it looks very much as though Mr. Weld, like many another English traveler who has written a book on his return home, has been inclined to overstate the truth.

In these days of comparative personal cleanliness some of the most disgusting of the insect annoyers of man have dropped out of sight. The lice, which in former days were common in all classes of society from king to peasant, are now comparatively unknown. The itch disease, which carried off many a famous character in history, is equally rare. That it still persists, however, is shown by an occasional case reported in medical journals. For example, Dr. Robert Hessler, of Indianapolis, reported in 1892 a case in his own practice of typical Norway itch in which the itch mites were present in the skin of the patient in enormous numbers. A rough estimate showed seven million eggs and two million mites.

Those of us who live in a reasonably civilized way are confined, in our experience of annoying insects, largely to the forms mentioned in our opening paragraph, namely, mosquitoes and house flies and rarely fleas; but a glance through medical literature reveals the existence of more or less frequent cases of such a nature that they are little less than horrible. Prominent among these are the cases of so-called Myasis, and especially those resulting from the attacks of the screw-worm fly, Compsomyia macellaria.

Residents of temperate regions are fortunate as compared with those of tropical regions in respect to the personally annoying insects. Our troubles from these individually insignificant causes are intensified to a degree in warmer countries, where the comfort of the individual absolutely depends upon the adoption of measures, always difficult and frequently impracticable, to exclude insects from his person and from his food. This is so well known in these days of numerous books of travel that I will close this aspect of our question simply with a quotation from a poet of the Indies, written many years ago:

> "On every dish the booming beetle falls,
> The cockroach plays, or caterpillar crawls;
> A thousand shapes of variegated hues
> Parade the table and inspect the stews;
> To living walls the swarming hundreds stick,
> Or coart a dainty meal, the oily wick;
> Heaps over heaps their slimy bodies drench,
> Out go the lamps with suffocating stench.
> When hideous insects every plate defile,
> The laugh how empty, and how forced the smile!"

AS CARRIERS OF DISEASE.

Manson's demonstrated transmission of the filaria diseases of the East (elephantiasis, chyluria, and lymph scrotum) by insects; the discovery by Salmon and Smith of the carriage of the germ of Texas fever by the well known Southern cattle tick; the discovery by Koch of the fact that the Tsetse fly of Africa is so destructive to animals not by its bite alone, but by carrying into the circulation of the animal that it attacks the micro-organisms of disease; the demonstration by Howe and others of the previously suspected fact that the purulent conjunctivitis of the Egyptians is spread by the house fly; the partly proved hypothesis of Manson and Grassi of the relation existing between mosquitoes and malaria; the circumstantially proved carriage of the germs of Asiatic cholera and typhoid fever by flies; the demonstration claimed by Finlay of the carriage of a mild type of yellow fever by mosquitoes; the suggestion by Hubbard that the "pink eye" of the South is spread by Hippelates; the well recognized fact among the Europeans of the Fiji Islands that without a veil a serious native eye disease will spread through the medium of gnats; the suggestion by Symond of the agency of fleas in the spread of the bubonic plague; the demonstration of anthrax bacilli in malignant pustules in human beings, caused by the bite of Tabanus and Stomoxys—all indicate an important and very injurious function of insects practically unsuspected until comparatively recent years. It is, in fact, a rapidly increasing field of investigations, the possibilities of which cannot be accurately established at the present time. It is, however, not a field which should be left entirely to the medical bacteriologist; the entomologist should have a share. The life histories and habits of the insects concerned in the damage should be thoroughly understood, since it is not impossible that otherwise the medical investigators may find themselves arriving at perhaps unwarranted conclusions. For example, it is a fact probably unknown to the medical men who may be strongly impressed by the suggested carriage of typhoid germs by flies, that the house fly so common in our dining rooms does not breed in and rarely visits human excrement, while those other kinds of flies which do so breed are rarely attracted to articles of food used by human beings. In the crowded and unnatural conditions of army camps, however, and especially where cavalry regiments are stationed, so that there are great amounts of horse manure, the house fly may breed in such enormous numbers as to render of very likely occurrence a departure from the normal food habits of the adult.

Enough has been shown, however, to emphasize the potentiality of this phase of insect injury.

BENEFITS AS DESTROYERS OF INJURIOUS INSECTS.

The economic bearings of insect enemies of insects are very great, and perhaps this is, all things considered, the most important of the beneficial functions of insects as a class.

In the eternal warfare of organism upon organism, in the perpetual strife of species, one preying upon another and that upon a third, the complications of relations of forms which determine the abundance of one species and the scarcity of another are nowhere more marked than among the insects. In fact, to the student of insects who has followed out even a single chain of these inter-relationships, the thought must necessarily come that upon its organic environment, and especially upon its relations with its living neighbors of the animal kingdom, depend the chances of a species not only for increase, but for survival, almost to no lesser degree than upon its inorganic environment. Temperature is the great factor which controls the geo-

* By Dr. L. O. Howard. Address of the retiring President of the Biological Society of Washington, delivered January 18, 1899.

graphical distribution of life, and temperature is at the back of all these apparent living first causes which control the abundance of a species in a given region, provided we trace them far enough. Yet these living causes, themselves affected by other living causes in an almost endless chain, sometimes, to all appearance, dwarf even temperature as a controlling factor.

There is not a species of insect that has not its natural enemies in the guise of other insects; there is not one of these other insects which has not its own insect foes. From a single species of Bombycid moth, the larvæ of which frequently damage forests in Europe to an alarming extent, there have been reared no less than sixty species of hymenopterous parasites. From a single caterpillar of Plusia brassicæ have been reared 2,528 individuals of a little hymenopterous parasite, Copidosoma truncatellum.*

Outbreaks of injurious insects are frequently stopped as though by magic by the work of insect enemies of the species. Hubbard found, in 1890, that a minute parasite, Trichogramma pretiosa, alone and unaided, almost annihilated the fifth brood of the cotton worm in Florida, fully ninety per cent. of the eggs of this prolific crop enemy being infested by the parasite. Not longer ago than 1895, in the city of Washington, more than ninety-seven per cent. of the caterpillars of one of our most important shade-tree pests were destroyed by parasitic insects, to the complete relief of the city the following year. The Hessian fly, that destructive enemy to wheat crops in the United States, is practically unconsidered by the wheat growers of certain States, for the reason that whenever its numbers begin to be injuriously great its parasites increase to such a degree as to prevent appreciable damage.

The control of a plant-feeding insect by its insect enemies is an extremely complicated matter, since, as we have already hinted, the parasites of the parasites play an important part. The undue multiplication of a vegetable feeder is followed by the undue multiplication of parasites, and their increase is followed by the increase of hyperparasites. Following the very instance of the multiplication of the shade tree caterpillar just mentioned, the writer was able to determine this parasitic chain during the next season down to quaternary parasitism. Beyond this point, true internal parasitism probably did not exist, but even these quaternary parasites were subject to bacterial or fungus disease and to the attacks of predatory insects.

The prime cause of the abundance or scarcity of a leaf-feeding species is, therefore, obscure, since it is hindered by an abundance of primary parasites, favored by an abundance of secondary parasites (since these will destroy the primary parasites), hindered again by an abundance of tertiary parasites, and favored again by an abundance of quaternary parasites.

The subject of practical handling of insect enemies of insects has come into great prominence during the past ten years. The suggestion by the Rev. Dr. Bethune, of Canada, many years ago, of the desirability of importing the European parasite of the wheat midge into America was probably the first published international suggestion of this nature, and, although some subsequent correspondence between English and American entomologists ensued, no parasites were actually sent over. Later, attempts were made by LeBaron in the case of a parasite of the oyster-shell bark-louse of the apple, and by Prof. Riley in the case of a parasite of the plum curculio, to transport parasites from one section of the United States to another, both attempts meeting with some slight success.

In 1873 Planchon and Riley introduced an American predatory mite, which feeds in this country on the grape vine Phylloxera, into France, where it became established, but where it accomplished no appreciable results in the way of checking the spread of this famous vine pest.

In 1874 efforts were made to send certain parasites of plant-lice from England to New Zealand, without recorded results of value.

In 1880, in an article upon the parasites of American scale insects, the writer showed that international transportation is especially easy, and especially desirable in the case of these insects.

In 1883 Dr. Riley succeeded in importing a common European parasite of the imported cabbage worm into this country, where it established itself and has since proved to be a valuable addition to our fauna.

In 1891 the same distinguished entomologist brought about the importation of one of the European parasites of the Hessian fly through the assistance of Mr. Fred. Enock, of London. This parasite maintained itself in this country certainly as late as 1895, but has accomplished no appreciable good, so far as has been ascertained, in limiting the increase of this destructive enemy to wheat.

All previous experiments of this nature were dwarfed into insignificance by the astounding success of the importation of Novius (Vedalia) cardinalis, a ladybird beetle, from Australia into California in 1889. This importation was made, as will be remembered, by Mr. Albert Koebele, an attaché of the Division of Entomology of the United States Department of Agriculture, whose expenses, however, were paid out of a fund appropriated to the Department of State, for the purpose of securing a representation from this country at the Melbourne Exposition. A California man, the late Mr. Frank McCoppin, happened to be at the head of the Exposition Commission; and, while the late Dr. C. V. Riley was endeavoring in Washington to induce the Department of State to set aside a sum, from the Exposition fund, for the expenses of Mr. Koebele, representatives of the State Board of Horticulture of California were pressing the same facts upon Mr. McCoppin, the head of the Commission. These efforts were being made independently and without consultation, hence it happened that after Mr. Koebele had succeeded in sending live Vedalias to California, and after these insects, by their rapid multiplication and voracious habits, had absolutely destroyed the cottony cushion scale in the orange groves of the State, a result which practically saved millions of dollars to California, and which attracted the attention of everyone interested in science or agriculture, a most unfortunate controversy ensued between Dr. Riley and the California State Board of Horticulture as to the placing of the credit of carrying out this wonderfully successful experiment. This controversy embittered the last days of both Dr. Riley and Mr.-McCoppin, and was the cause of a disturbance of the formerly pleasant relations between the United States Department of Agriculture and the State Board of Horticulture of California, which has only recently been overcome.

Following this successful experiment, the same insect, Novius cardinalis, was sent to South Africa, where it exterminated the white or fluted scale in that colony. The next year it was sent to Egypt, where it exterminated a congeneric scale insect in the gardens of Alexandria.

The following year Mr. Koebele, still an agent of the United States Department of Agriculture, was sent with the consent of the Hon. Jeremiah Rusk, but at the expense of the California State Board of Horticulture, to Australia, New Zealand, and the Fiji Islands, for the purpose of securing other valuable beneficial insects for importation into California. Thousands of such insects, comprising a number of different species, nearly all, however, of them coccinellids, or ladybirds, were sent over and established in California. Several of these species are still living in different parts of the State. The overwhelming success of the importation of Novius cardinalis was not repeated, but one of the insects brought over at that time, namely, Rhizobius ventralis, has unquestionably ridden many olive groves of the destructive black scale, and is to-day present in many other orchards in such numbers that the scale practically makes no headway.

After this second Oriental trip the relations between the Department of Agriculture and the State Board of Horticulture of California became so strained that the California agents of the Department were given their choice by the Honorable Secretary of Agriculture to resign their positions or be transferred to Washington. Mr. Koebele resigned and was soon after employed by the then newly established Hawaiian Republic for the purpose of traveling in different countries and collecting beneficial insects to be introduced into Hawaii for the purpose of destroying injurious insects. It is difficult at this time to ascertain the exact results of the more recent portion of this work. Mr. Koebele's own published reports have dealt less with results than with the details of the introduction of insects, and anonymous newspaper reports are not to be accepted as scientific evidence. Fortunately, however, one of the collectors of the British Association for the Advancement of Science, Mr. R. E. C. Perkins, was in Hawaii during 1896 and made a report on Mr. Koebele's work to the committee appointed by the Royal Society and the British Association for investigating the fauna of the Sandwich Islands, which was published in Nature for March 25, 1897. From this report it appears that the introduction of Coccinella repanda from Ceylon, Australia, and China was so successful in the extermination of plant lice upon sugar cane and other crops as to obviate all necessity for spraying. The introduction of Cryptolæmus montrouzieri from Australia resulted in the entire recovery of the coffee plants and other trees which were on the point of being totally destroyed by the scale insect known as Pulvinaria psidii. Eight other introduced species had at the date of writing (November, 1896) been entirely naturalized and were reported as doing good work against certain scale insects. A Chaleis fly, Chalcis obscurata, introduced from China and Japan, multiplied enormously at the expense of an injurious caterpillar which had severely attacked banana and palm trees. Mr. Koebele, when visiting Washington during November, 1898, mentioned a number of other importations of beneficial insects into Hawaii, about which it is as yet too early to speak.

A very recent instance of an international importation of striking value is the sending of Novius cardinalis from this country to Portugal, where the white or fluted scale has been checked and in many orchards exterminated in the course of a single year. This importation was made by the writer with the invaluable assistance of the California State Board of Horticulture.

Other experiments in this line are under way. A parasite of certain wax scales, which are abundant and injurious in the South, has been imported by the writer from Italy, with the co-operation of Prof. Antonio Berlese, of the Royal Scuola di Agricoltura di Portici; while an effort is being made to bring from Europe insects which will prey upon the Gypsy moth which has been so great a plague about Boston; and other parasites of injurious scale insects in foreign countries are being studied with the purpose of eventually obtaining their introduction into the United States.

(To be continued.)

* This observation, which for some years "held the record," as the expression is, was made by Mr. Pergande, of the U. S. Department of Agriculture. Recently, however, Prof. A. Giard, of Paris, has more than 3,000 specimens of the same parasite reared from a Plusia caterpillar.

THE BAD LANGUAGE OF WILD BIRDS.

By CHARLES A. WITCHELL.

JUDGING by what one hears of the utterances of animals generally, it would seem that many of the notes of birds are interpreted too poetically by observers. In the case of many animals, the facial expression is capable of sufficient variation to clearly prove the character of the sounds by which it is accompanied. When a dog or a cat snarls, for instance, we know that the sound is intended to express hatred and a threat of attack. The lowing of a cow or of a calf, the bleating of a kid, the snorting of a horse, and its whinnying, can hardly be misunderstood.

But the meanings of the cries of birds are less obvious. The cooing of a dove, or the warbling of a fluent singer, may seem to be as expressive as any note of the quadrupeds just mentioned; but when attention is given to the actions which accompany the cries of birds, an observer finds that some very pleasant sounds are incidental to very unkind behavior. In a few cases the combativeness of a bird is fairly well suggested by its cry—as occurs in the common fowl, whose "crow" is as defiant as a bugle blast. The shriek of the woodland jay, also, is very expressive. These sounds, however, do not represent the greatest passion. We must listen to birds actually engaged in combat in order to hear the expression of their utmost hate—their worst language; and listening thus, we often make the discovery that the sound accompanying an attempt at murder is closely like (sometimes apparently identical with) sounds which seem to be joyous song.

The little brown wren mounts the top of the hedge and sings a sprightly song. The notes seem to be the spontaneous outpouring of joy. Twenty yards farther along the hedge another wren mounts to the topmost twig, perks his tail, and utters a similar lively tune. Number one flies a little way toward number two, and sings again. Here, then, is a pleasing sylvan duetto! But soon the wrens are fighting furiously, tumbling over and over each other at the bottom of the hedge, while at intervals snatches of the same little ditty are heard. They sing, in the intervals of fighting, what seemed a song of peace and love. In view of what the birds are doing, it may be surmised that their language at this moment is very bad indeed.

But instead of the sprightly wren, the sedate robin may be under observation. If a singing robin be watched, and especially in autumn, he will be seen to attack any other singing robin which may be near; yet the birds will be singing all the while, and their songs will be like the ordinary songs of the species, though a trifle sharper in tone. The music is evidently intended to convey the animosity of the birds. The hedge sparrow twitters in quite a subdued tone when fighting; yet it nevertheless seems to be singing. The willow wren sings its ordinary song when about to attack a rival. The chiffchaff, however, does not employ his cheerful strain on the like occasion. The nightingale is somewhat pugnacious, and I have several times seen two fighting (I once saw three), but no song notes were then given.

Among the finches and buntings a combat is often accompanied by a slight twittering, somewhat similar to rapid repetitions of the call note, malice and love having thus the same tone; but some species employ a particular note. The chaffinch has only one cry when fighting, be his enemy bird or beast. That cry is the common note "tink," or "fink." The greenfinch then utters a low, rough cry, something like "gupgupgup," repeated very rapidly. The male house sparrow is one of the most silent of fighters. (The casual observer will say that this is one of the most untrue of allegations.) When male sparrows intend to fight, they hop about restlessly near each other, their feathers held very close, and their tails flirting up and down almost continuously. Presently one of the birds darts at the other and tries to give him a lance thrust with the bill, the other springs aside, and the aggressor alights near, and the flirting of the tails continues. But all this time the birds utter no cry. When the contest has reached the stage of a struggle in the nest-place, however, there is some noise, scuffling, and screaming. The cries are not the tones of love; they are expressions of fury. When male sparrows are noisily clustering around a female bird, their cries may be those both of love and fear; but these assemblies require close attention before the nature of the cries employed can be ascertained.

There are many species which give the full song during combat. I have heard the full song of the tree pipit sung by a bird fighting furiously. When first seen the birds were fighting in flight; they fell to the ground together, and in this position, and when I was not more than three yards distant, one of them uttered the full song, including even the final "whee whee whee," which is usually uttered while the bird is descending on outstretched motionless wings.

The common pied wagtail, when attacking another, utters cries which seem to be his ordinary call notes; and the same incident may be observed in the skylark. Last summer a lark was singing as usual above his meadow, and another singing lark approached and swooped at him. The new comer was vigorously repulsed, though not until some pretty flying and stooping had been performed; and the birds were singing all the while. They were evidently rival neighbors, but in this instance, as in those above mentioned, mere rivalry and emulation would not account for the behavior of the birds. This must be credited to hatred and ill will.

In many species, therefore, we cannot easily distinguish the tone of love from that of hate, unless we also consider the contemporaneous behavior of the birds. And even then we may easily err; for when a melodious singer is perched in a tree, or poised on the wing, we cannot tell whether his notes are addressed to his mate or to his enemy. Unfortunately, it is not only among birds that the same tone is employed toward both of these objects!

So far, I have not met with anyone who is paying attention to this branch of bird song; yet it is a really important one, with a basis of fact to indicate the lines of investigation to be followed. The sparrow and several other finches have cries which are preferably employed during combat. Some singers, as the robin and thrush, sing when fighting with others of their own species, but not when fighting birds of alien species, and there are many which do not sing at all when fighting. The starling is one of the last. When threatened by another, or meditating an attack, it is silent, and at the moment of the encounter only a slight cackling is heard. This sound may most often be heard in September and October, when the birds are striving for the possession of nesting sites in which to roost during the winter.

But though the starling never expresses malice in song, he undoubtedly often sings a love song, for he will fan his mate with his wings while singing; and she, with head raised and tail drooping, adds a softer strain to his music.

The blackbird is another singer which never employs song as a threat. His combats are accompanied by a metallic clicking sound, with which most of us are familiar. The song thrush, however, never has a contest with another of his kind without twittering an accompaniment.

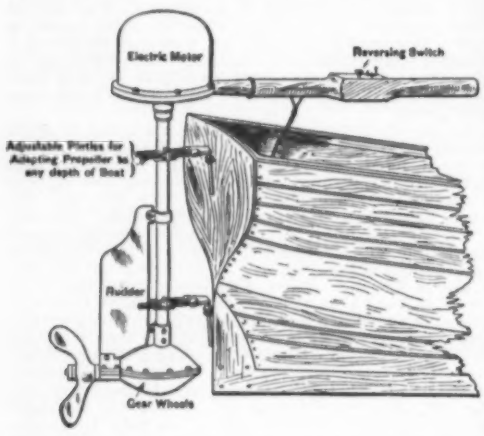
It cannot be said that any of these birds is restricted to one set of tones both for anger and for song (as occurs to some extent in the common duck), for all of them have special cries of alarm and anger, which they utter when frightened by a predaceous beast. The robin employs his rattling note of alarm; the thrush, when its nest is threatened by the jackdaw, makes a great outcry like that of the mistle thrush; the tree pipit has an alarm which is given when the nest is threatened; the brown wren repeats a common note when frightened; and the others have a similar variety of cries.

These remarks are intended to prove the importance of carefully analyzing a bird's notes before attempting

to define their meaning. The subject is so new that anyone who will carefully notice may do good work, and at no cost of bird life. Nor can it reasonably be urged that this analysis would rob the poet of some common symbols. No one would unnecessarily deprive him of any, but he should know that while the blackbird, starling, chaffinch, and others may be pouring out the truest love notes, the robin, thrush, hedge-sparrow, and others, though also singing, may be using the very "Billingsgate" of birds.

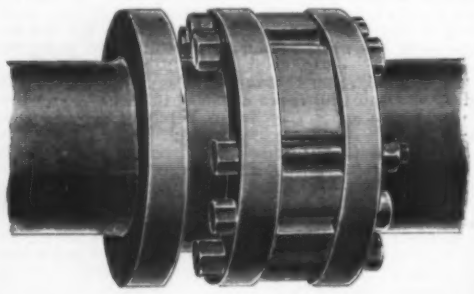
PORTABLE ELECTRIC PROPELLER FOR BOATS.

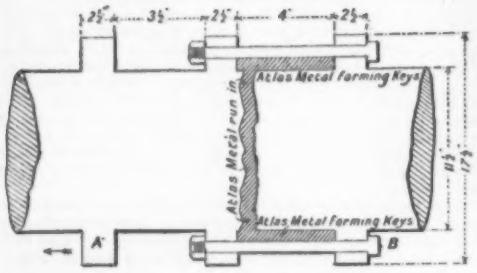
IN connection with the correspondence recently published in our columns on the subject of electric canal haulage, Mr. E. A. McLachlan has sent us particulars of a portable electric propeller, which he can fit to any boat, although they may not have been originally designed for electrical propulsion. The apparatus, which is illustrated in the accompanying figure, was originally intended for river boats, but it is equally applicable to canal barges. To apply it, it is only necessary to unship the ordinary rudder, and attach the combined propeller and rudder, as shown. Storage batteries are placed on the floor of the boat, and connected by a twin flexible cable to the motor switch on the tiller handle. For ordinary pleasure boats a ½ horse power motor is used, and in every case it runs on ball bearings, its spindle being vertical. The weight of this size of motor-rudder is only 35 pounds and it is claimed that, with 20 storage cells of a suitable size, sufficient power can be obtained to drive a 16 foot sea dinghy, with five passengers on board, at five miles an hour for five hours. The 20 cell storage battery weighs about 180 pounds. As already mentioned, the apparatus is made in larger sizes, 15 horse power being the maximum.—The London Electrician.



REPAIRING A SCREW SHAFT.

THE accompanying engravings, says The Engineer, illustrate a very clever repair of a propeller shaft effected in fifty-one hours by the aid of "Atlas" metal. The ship is the "Royal Prince." The shaft broke in the thrust block, which, it will be seen, is of unusual construction—there are only three collars. The chief engineer of the ship, Mr. Thomas, carried out the repair in the way shown by the sketch. Holes were drilled in two of the collars, and through these bolts were passed, as shown by the perspective view. These bolts could obviously have been twisted across, unless some means were devised for putting them in shear. This was done by running in "Atlas" metal, to fill the gap between the end of the fractured shaft and to form a ring round the joint.





The thrust was exerted in the direction of the arrow by the forward collar, *A*, and by it alone. The repair was so successful that the ship steamed 180 miles to Alexandria at half speed. All the "Atlas" metal in the ship was used up; if more had been available, Mr. Thomas would have cast a collar round the shaft at *B* so as to cover the heads of the bolts, and then by shifting the thrust block shoe he would have been able to go astern, which, as it was, was impossible.

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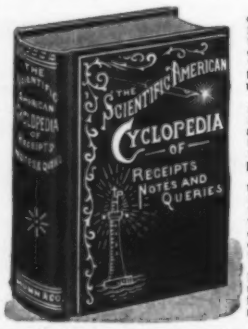

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